Protection of Plumbing from Expansive Soil

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1.0 ASPE Continuing Education Unit

Description

On sites where a Geotechnical Engineer has identified expansive soil conditions, where soil swells and shrinks excessively as the soil moisture contents change, slabs are typically designed by Structural Engineers to either be supported by a subgrade immediately under the slab or by deep foundation elements (such as piers or piles) with an under-floor space under the slab between deep foundation elements. Damage to plumbing in inaccessible areas under slabs and at transitions to exterior conditions is commonly and predictably caused by expansive soil when Mechanical Engineering specifications fail to sufficiently protect plumbing. Plumbing codes require that plumbing be protected so that stresses or strains do not exceed the capacity of the specified piping; the ASPE Plumbing Engineering Design Handbook advises that plumbing be protected from natural phenomena like soil movement when a structure is designed to be protected from the same phenomena. This presentation provides guidance on how Plumbing Designers should coordinate their plumbing design with other designers, on projects in expansive soil, to avoid known public health, safety and welfare issues and maintenance issues that have led to some significant lawsuits across the country, such as a federal case that found the designers negligent.

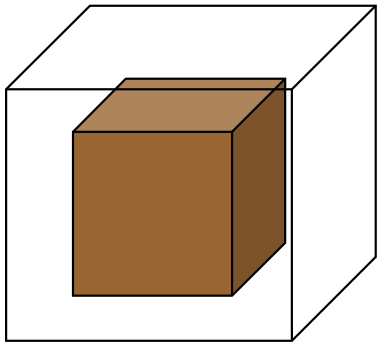
Learning Objectives

1. Identify when a Geotechnical Engineer has identified that expansive soil conditions exist at a project location.
2. Identify when a Structural Engineer has designed a “non-isolated” slab that is not isolated from soil swelling and shrinking forces, and when a Structural Engineer has designed an “isolated” slab that is isolated from soil swelling and shrinking forces.
3. Understand the difference between “non-isolated” plumbing where plumbing, hangers and supports under a slab are not isolated from soil swelling and shrinking forces, and “isolated” plumbing where plumbing, hangers and supports under a slab are isolated from soil swelling and shrinking forces; and, more specifically, determine if a specification for a void around plumbing creates an “isolated plumbing” or “non-isolated plumbing” condition.
4. Understand the history of failures that have occurred when “non-isolated plumbing” has been specified under “isolated slabs” and the piping material specification did not provide sufficient structural capacity to resist the stresses and strains that should have been anticipated, as well as the associated public health, safety and welfare problems, maintenance problems and lawsuits that have occurred as a consequence of these failures; and more specifically, understand a provision added to the 2024 IPC which clarifies previous plumbing code requirements and explicitly prohibits non-isolated plumbing under isolated slabs.
5. Specify plumbing that complies with plumbing codes by being protected from the damage that can be caused by expansive soil.

Intellectual Property Notice

Some of the methods and devices which are discussed in this presentation are inventions by various parties and have been **PATENTED** or are **PATENT-PENDING**. These methods and devices are referenced in this presentation without naming the manufacturers. A primary purpose of referencing these methods and devices is to discuss the relative technical advantages and disadvantages of various approaches used in the industry today. This presentation is not an inducement to patent infringement. Therefore, this slide is hereby providing **NOTICE** to all attendees that attendees should assume all methods and devices discussed in this presentation are **PATENTED** or are **PATENT-PENDING** unless they verify otherwise. Attendees are welcome to contact the Presenters and request more information related to intellectual property for any specific methods and devices referenced, if desired.

Expansive Soil



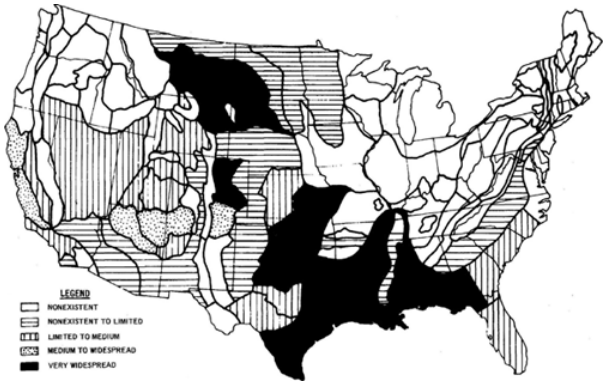


Image from the US Department of Transportation
Federal Highway Administration
Publication No. FHWA NHI-05-037 Chapter 7
May 2006

Increase in moisture content ➡ Increase in volume (Swelling)
Decrease in moisture content ➡ Decrease in volume (Shrinking)

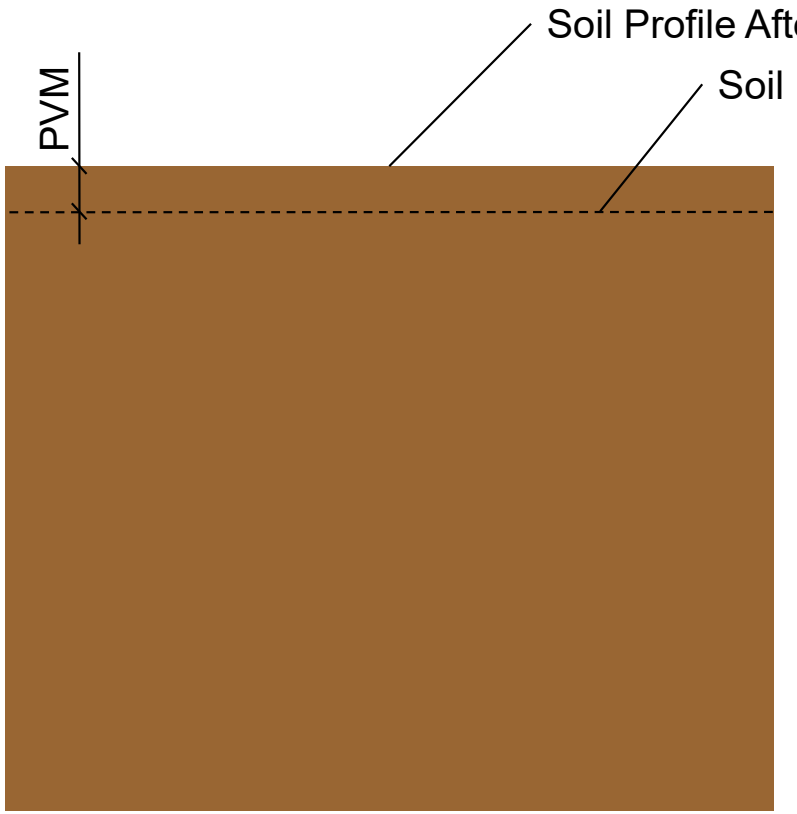
Expansive soils are the most costly natural hazard in the United States, causing more damage than all other natural hazards combined, including earthquakes, floods, tornadoes and hurricanes.

FEMA 1982 Special Statistical Survey:
Data, Injuries and Property Loss by Type of Disaster 1970-1980.
Washington D.C.

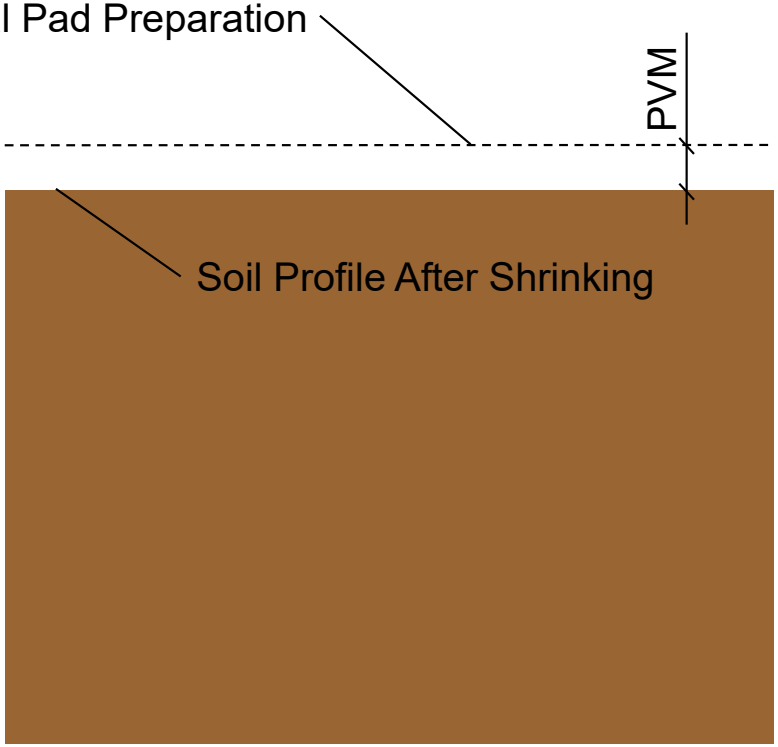
2024 IBC Section 1803.5 requires that a geotechnical investigation be performed where a Building Official determines that expansive soil is likely to be present, and defines “Expansive Soil” based on soil characteristics such as the “plasticity index” of the soil. Geotechnical Engineering reports will indicate if expansive soil was encountered in the borings and provide foundation recommendations, sometimes with recommendations related to utilities.

Estimated Potential Vertical Movement (PVM)

Examples of Geotechnical Engineering estimates of PVM for sites with expansive soil: 3”, 6”, 9” or 12”. These movements occur as moisture changes, which cause non-uniform upward and downward cycles.



Cross-Sectional View of the Soil on a Site



Cross-Sectional View of the Soil on a Site

Example Causes of Moisture Change

Seasonal variations in rainfall/drought

Irrigation Systems

Adding New Trees/Bushes

Removing Existing Trees/Bushes

Ponding Rainwater

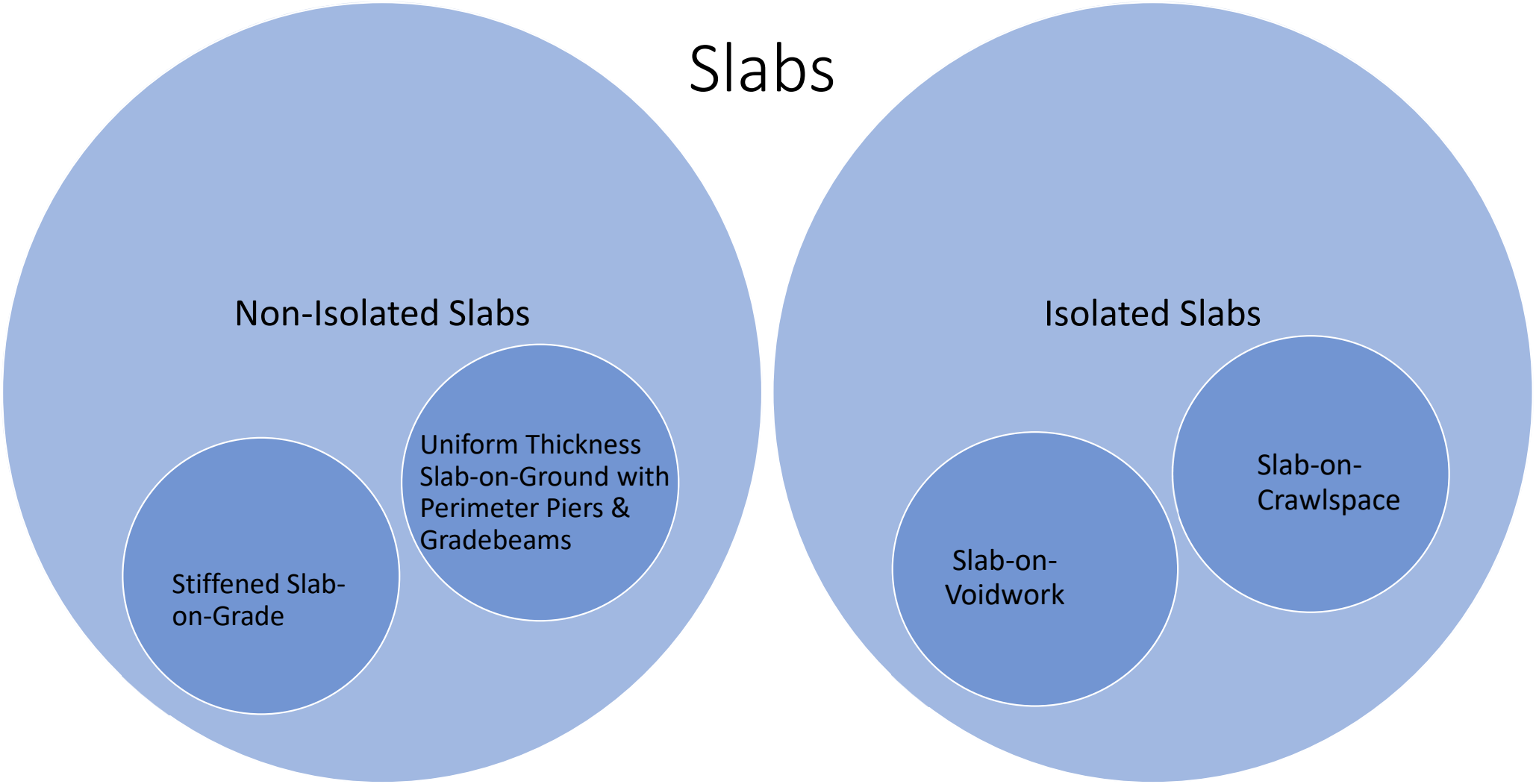
Exterior Plumbing Leaks

Under-Slab Plumbing Leaks

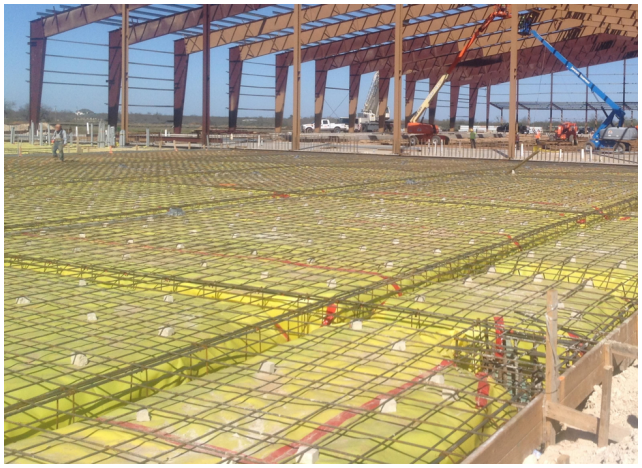
Adding Impervious Flatwork

Removing Impervious Flatwork

Slabs

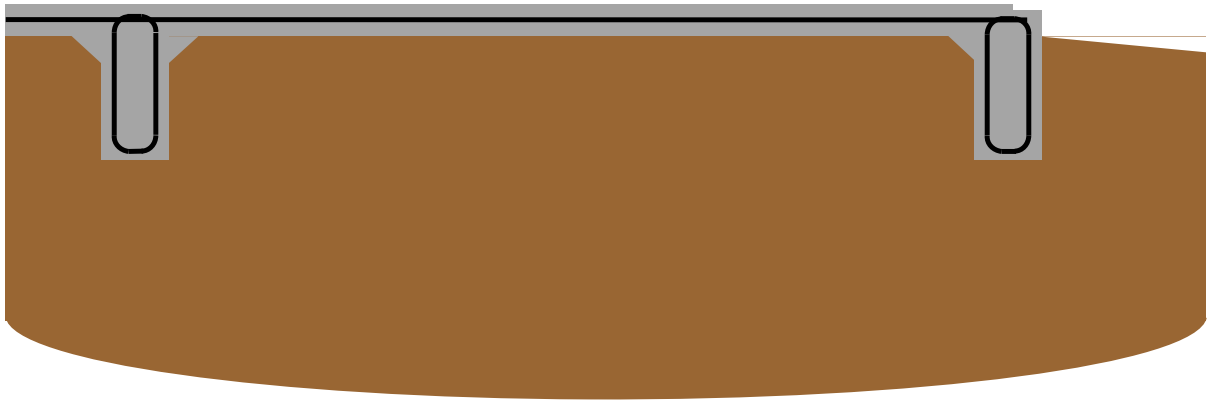

Non-Isolated Slabs
Uniform Thickness Slab-on-Ground with Perimeter Piers & Gradebeams
Stiffened Slab-on-Grade
Isolated Slabs
Slab-on-Crawlspace
Slab-on-Voidwork

Examples of Non-Isolated Slabs





Non-Isolated Slabs:
Stiffened Slab-on-Ground



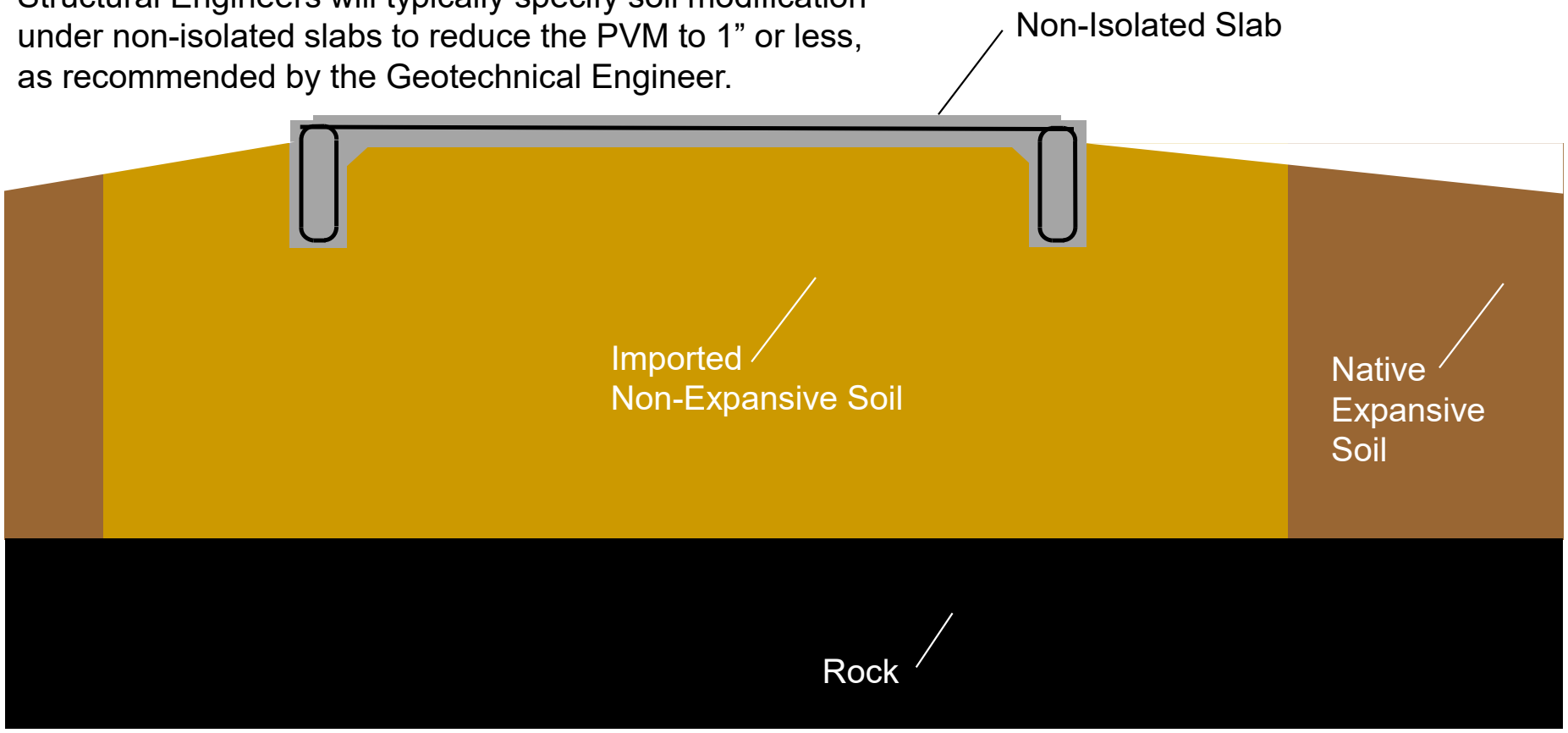
Non-Isolated Slabs:
Uniform Thickness Slab-on-Ground
With Isolated Grade Beams on Piers



The bottom and sides of grade beams are often formed. Grade beams typically bear on deep foundations (i.e., piers). “Soil Retainers” are retaining walls that prevent soil from entering the voidspace under the grade beams.

Example of Modifying Soil Under Non-Isolated Slabs

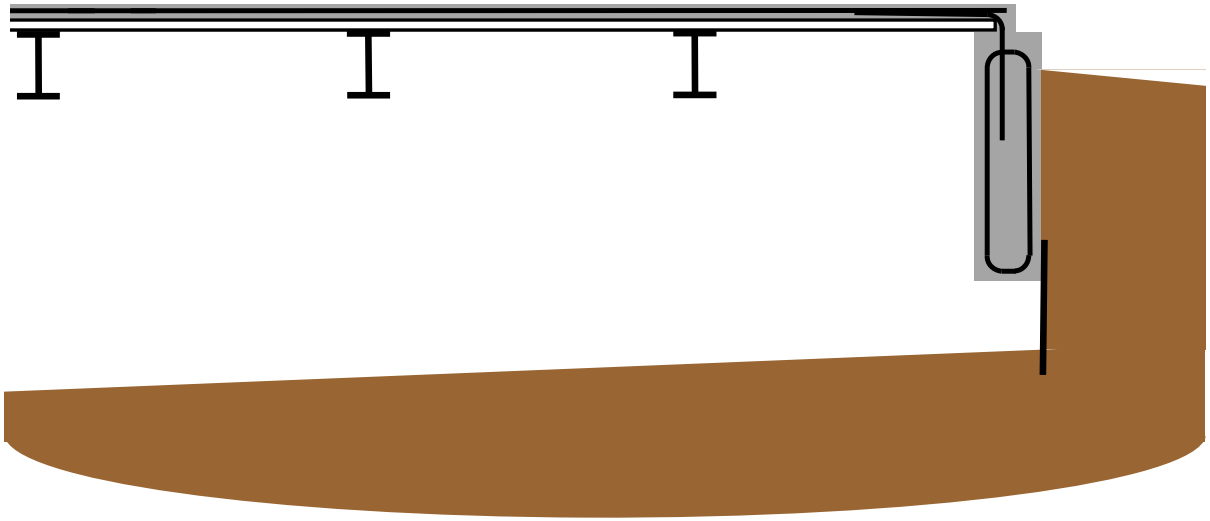
Structural Engineers will typically specify soil modification under non-isolated slabs to reduce the PVM to 1” or less, as recommended by the Geotechnical Engineer.



Sketches of Isolated Slabs

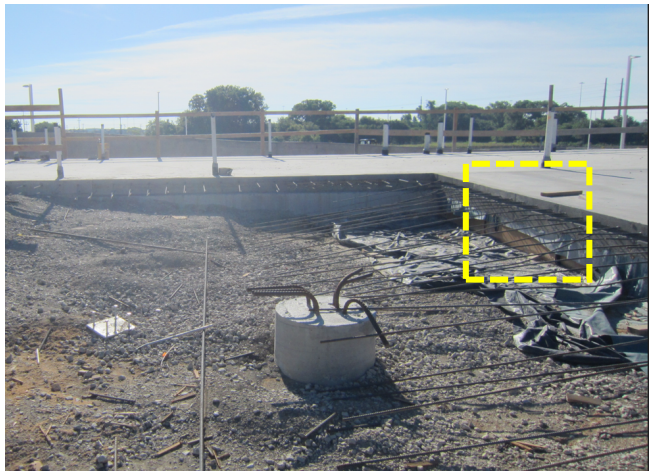


Isolated Slabs:
Slab-on-Crawlspace





Slabs often consist of a composite system of steel beams with slab poured on metal deck, precast concrete (double tees or hollow core planks). Grade beams and girder beams typically bear on deep foundations. “Soil Retainers” are retaining panels or walls that protect the voidspace under the perimeter grade beams.





Isolated Slabs:
Slab-on-Voidwork



When the slab is poured, the slab reinforcement and concrete are supported by a layer of “voidwork”. However, the voidwork is designed to degrade, collapse or otherwise create a space under the slab. Deep foundations support the slab permanently, on a grid about 20 ft each way.

Next 7 Slides have been extracted from the
2021 North Texas BPI Presentation titled

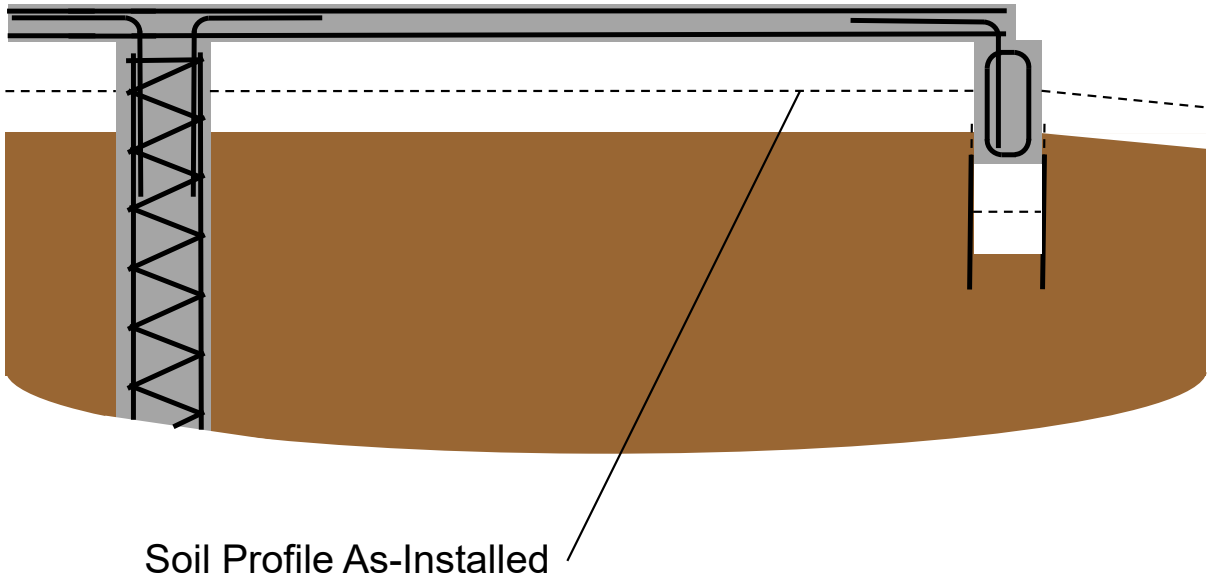
“Protection of Plumbing from Expansive Soil Under Foundations”

EXPANSIVE SOIL ILLUSTRATION

JF

General Under-Slab Settlement

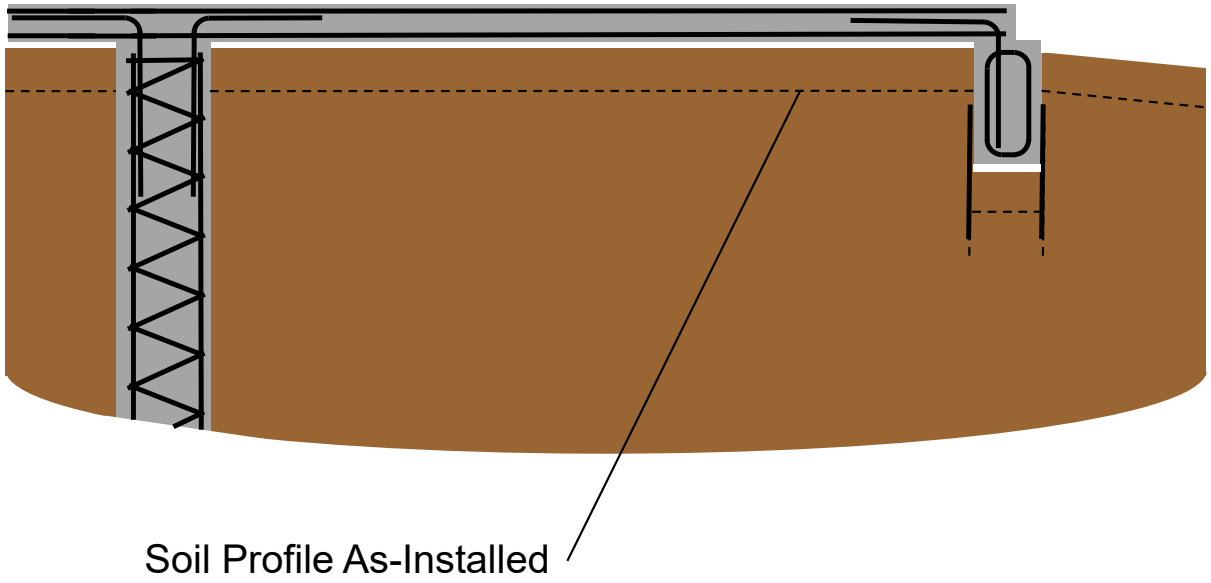
(Examples: Uncompacted Fill Settlement, Overburden Increase Settlement)



EXPANSIVE SOIL ILLUSTRATION

General Under-Slab Swelling

(Examples: Secondary Swelling, Unloaded Overburden Swelling, Forest Removal Swelling)

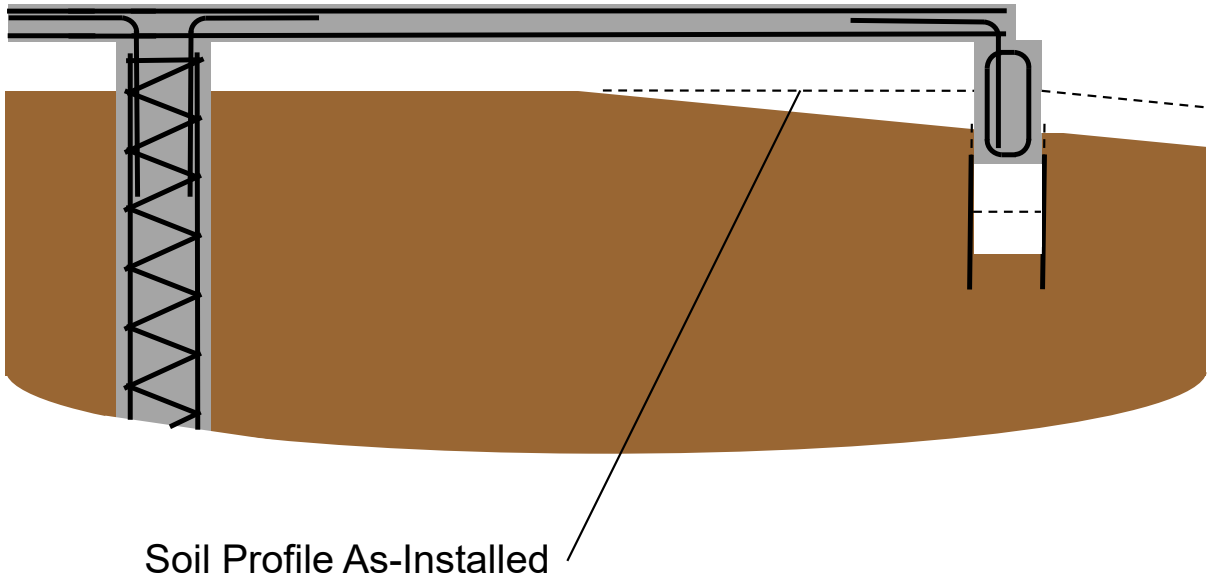


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EXPANSIVE SOIL ILLUSTRATION

Perimeter Under-Slab Shrinkage

(Examples: Seasonal Drying Shrinkage, Root-Induced Shrinkage)



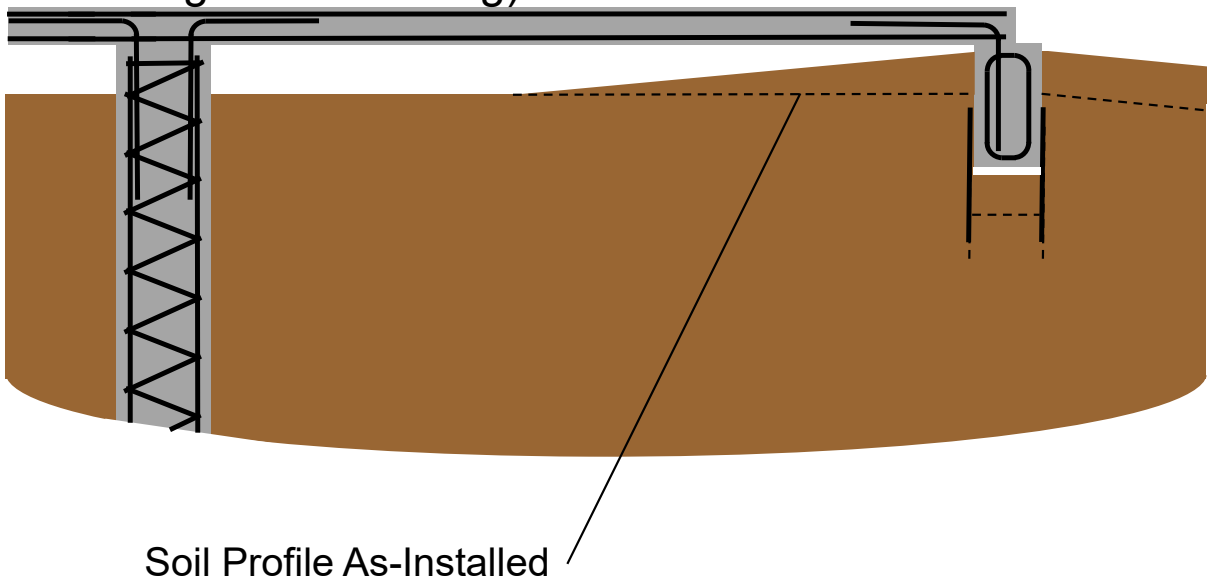
JF

EXPANSIVE SOIL ILLUSTRATION

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Perimeter Under-Slab Swelling

(Examples: Seasonal Wetting Swelling, Over-Irrigation Swelling, Scouring Rainfall Collection Swelling, Post-Construction Tree Removal Swelling, Perimeter Plumbing Leak Swelling)

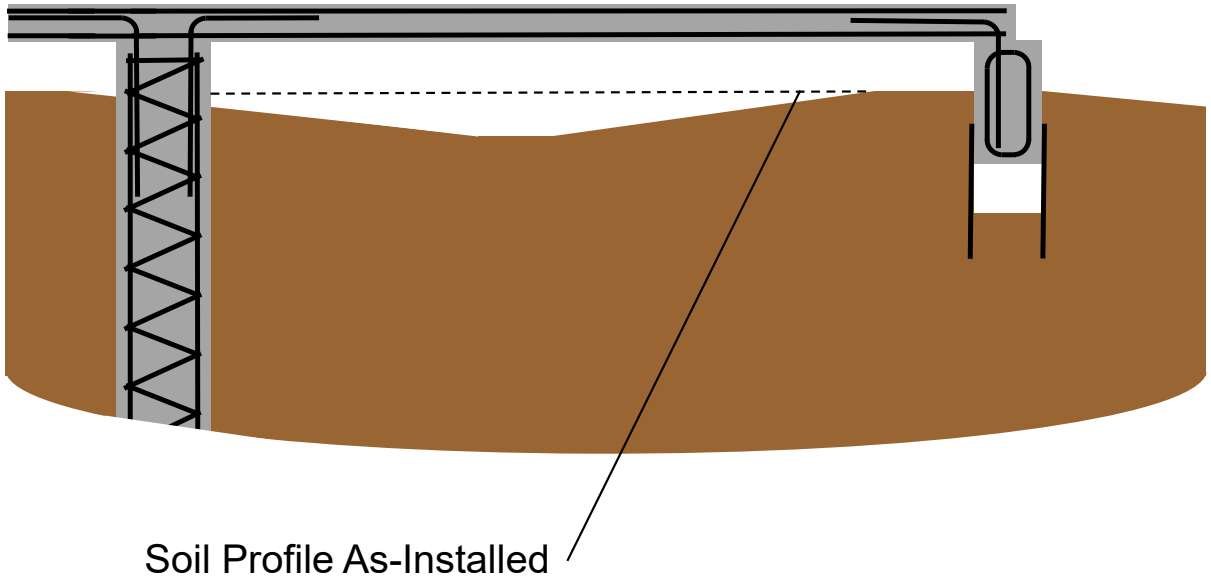


EXPANSIVE SOIL ILLUSTRATION

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Localized Under-Slab Settlement

(Example: Irregular Bedrock Elevations, Poor Fill Compaction, etc.)

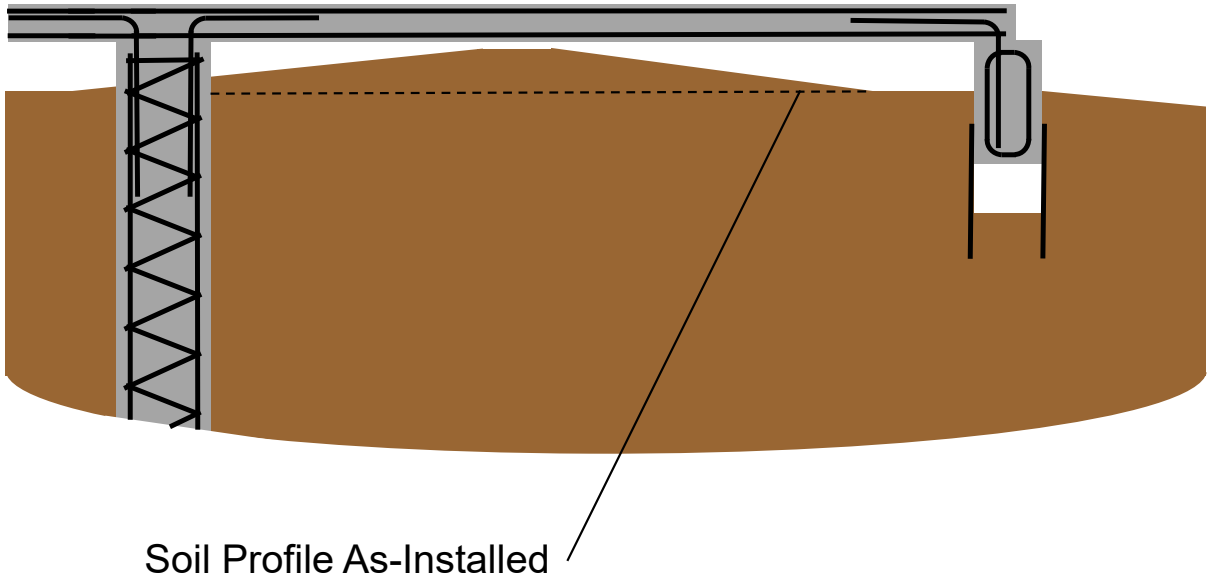


EXPANSIVE SOIL ILLUSTRATION

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Localized Under-Slab Swelling

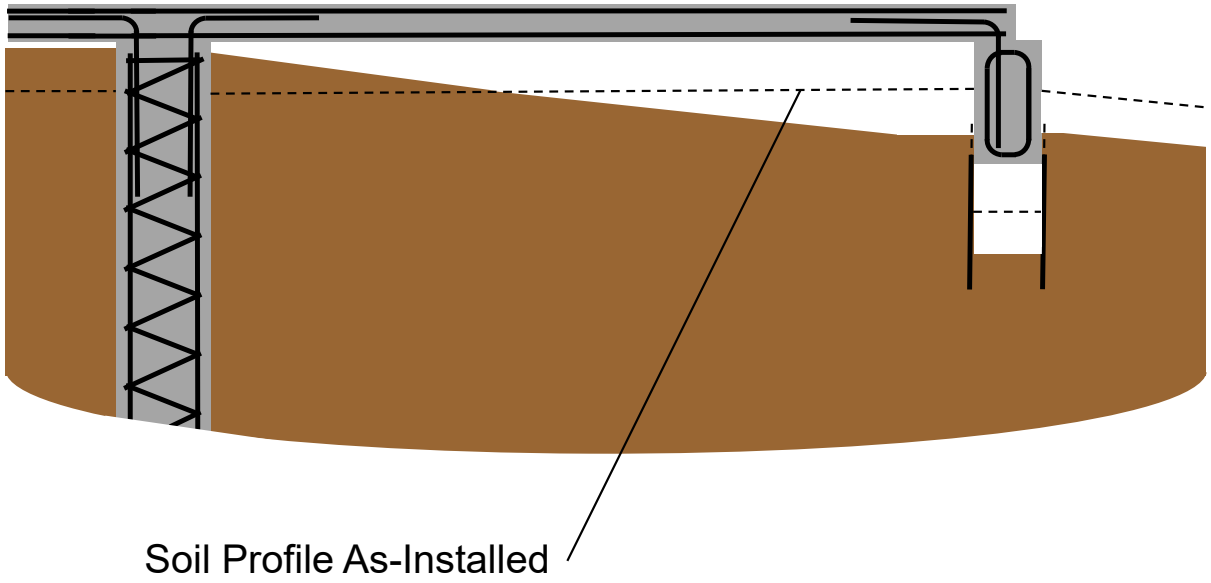
(Example: Under-Slab Plumbing Leaks, Isolated Pre-Construction Tree Removal without Proper Grubbing)



EXPANSIVE SOIL ILLUSTRATION

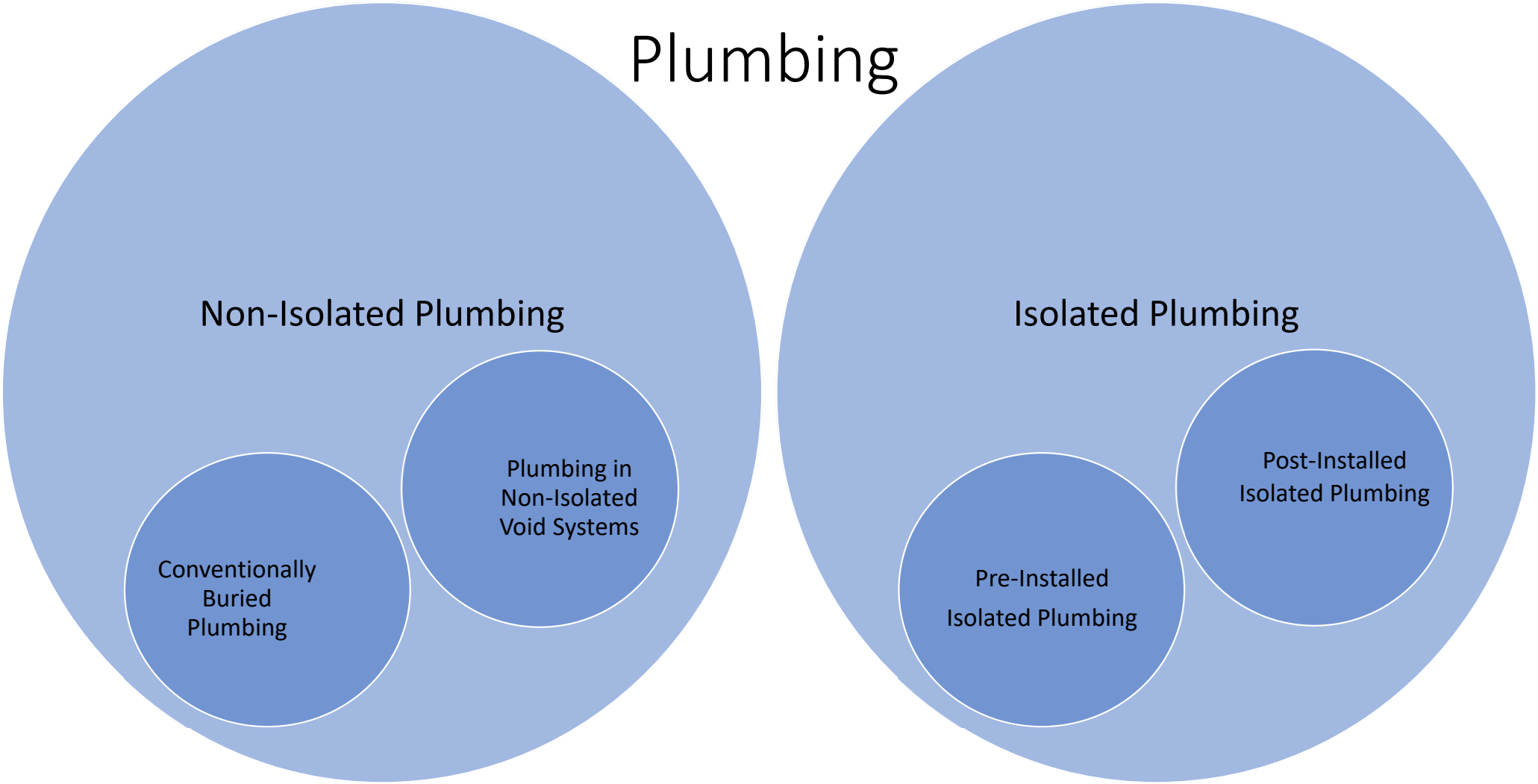
Complex Under-Slab Swelling & Shrinking

(Example: Moisture Migration in Partially Saturated Heterogenous Soil Conditions)



JF

Plumbing


Non-Isolated Plumbing
Conventionally Buried Plumbing
Plumbing in Non-Isolated Void Systems
Isolated Plumbing
Pre-Installed Isolated Plumbing
Post-Installed Isolated Plumbing

Plumbing



Steel mesh Non-Isolated Void Systems impart loads from soil to plumbing

Non-Isolated Plumbing

Plastic panel Non-Isolated Void Systems impart loads from soil to plumbing





Soil directly imparts load onto plumbing

Plumbing Hung After Slab Members Installed (Not Soil-Supported)



Isolated Plumbing

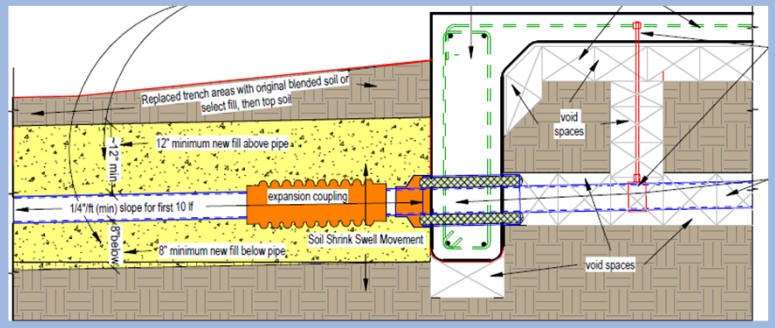


Permanent Support Beams Tied to Rebar In Slab Before Removing Temporary Support Rods

Temporary Support Rods Removed Before Slab Pour

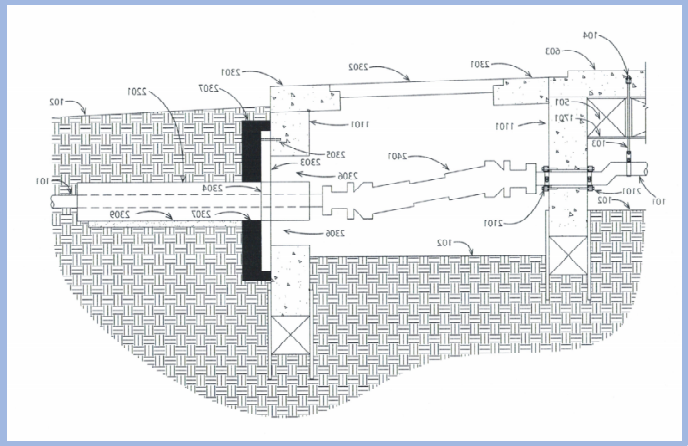
Plumbing Transitions

Non-Isolated Plumbing Transitions



Buried Flexible Plumbing that Does Not Accommodate PVM

Isolated Plumbing Transitions



Flexible Plumbing in a Vault that Accommodates PVM

Next 1 Slide has been extracted from the
2021 North Texas BPI Presentation titled

“Protection of Plumbing from Expansive Soil Under Foundations”

PLUMBING APPROACHES

DP

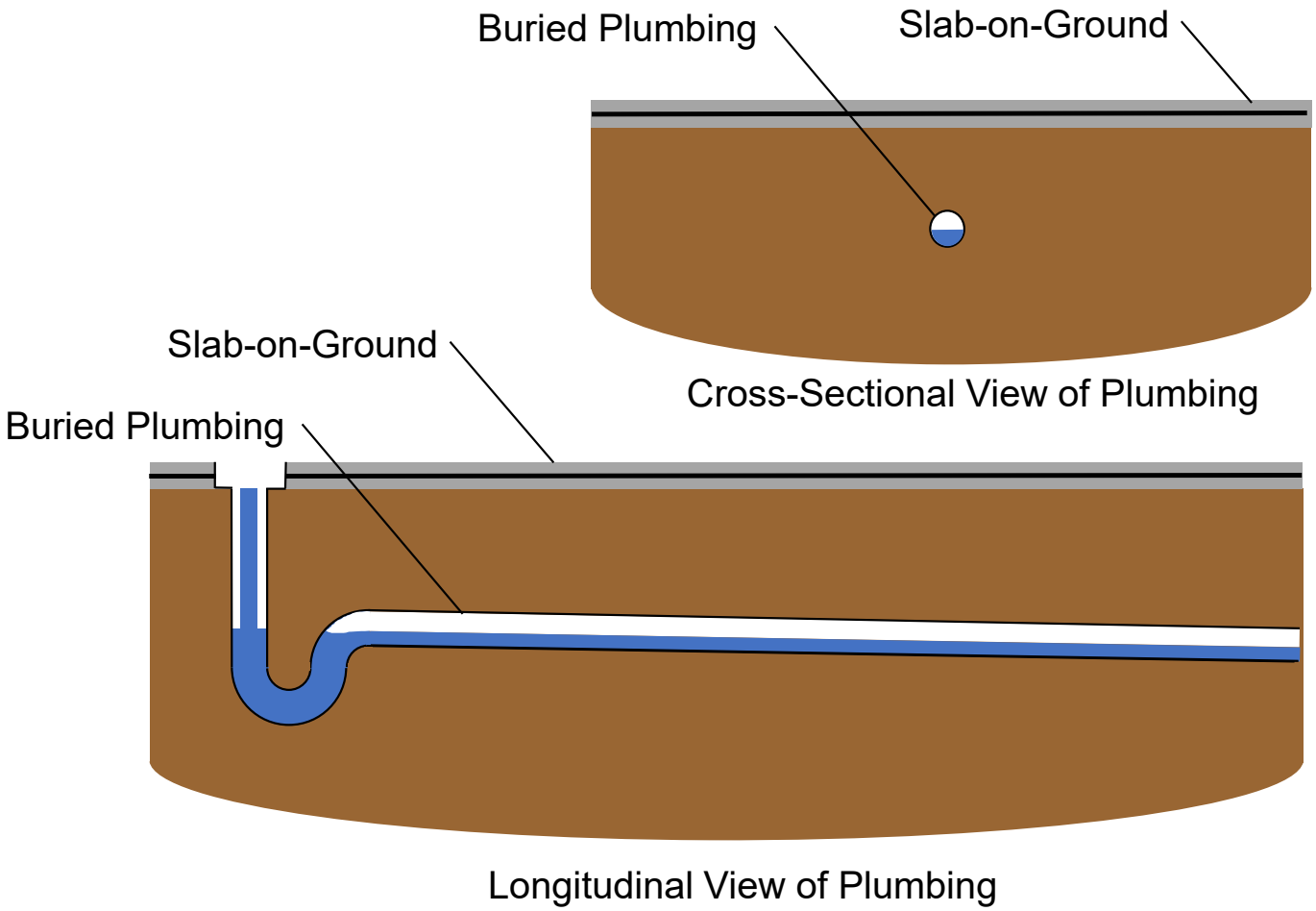
Non-Isolated Slabs (Slab-on-Ground) With Non-Isolated Plumbing

1. Expansive soil is typically removed or modified to reduce the Potential Vertical Movement (PVM) to 1” or less.

2. Because the plumbing is conventionally buried, the slab and plumbing underneath typically both move together as the soil swells/shrinks.

3. If plumbing becomes damaged by expansive soil movement, the slab can typically be sawcut above the damage and the plumbing can be repaired as feasible maintenance. A Structural Engineer may be involved if it is a post-tensioned slab, to address the cutting of post-tensioning strands and re-retensioning them, but the approach is generally the same.

Non-Isolated Plumbing under Non-Isolated Slabs is Acceptable

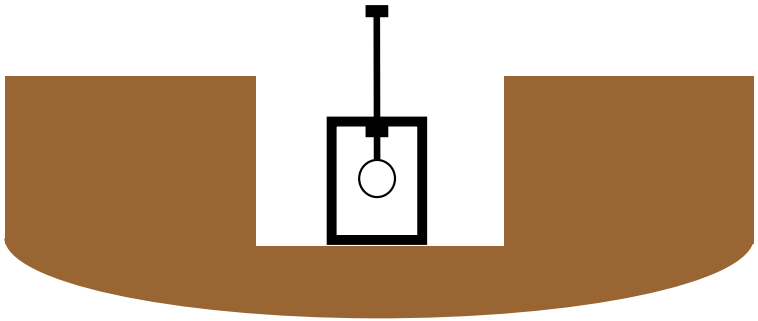


Mechanical Engineers that Specify Non-Isolated Plumbing Under Isolated Slabs are Negligent

There is only one party selecting the piping sizes and specifying permitted piping materials.

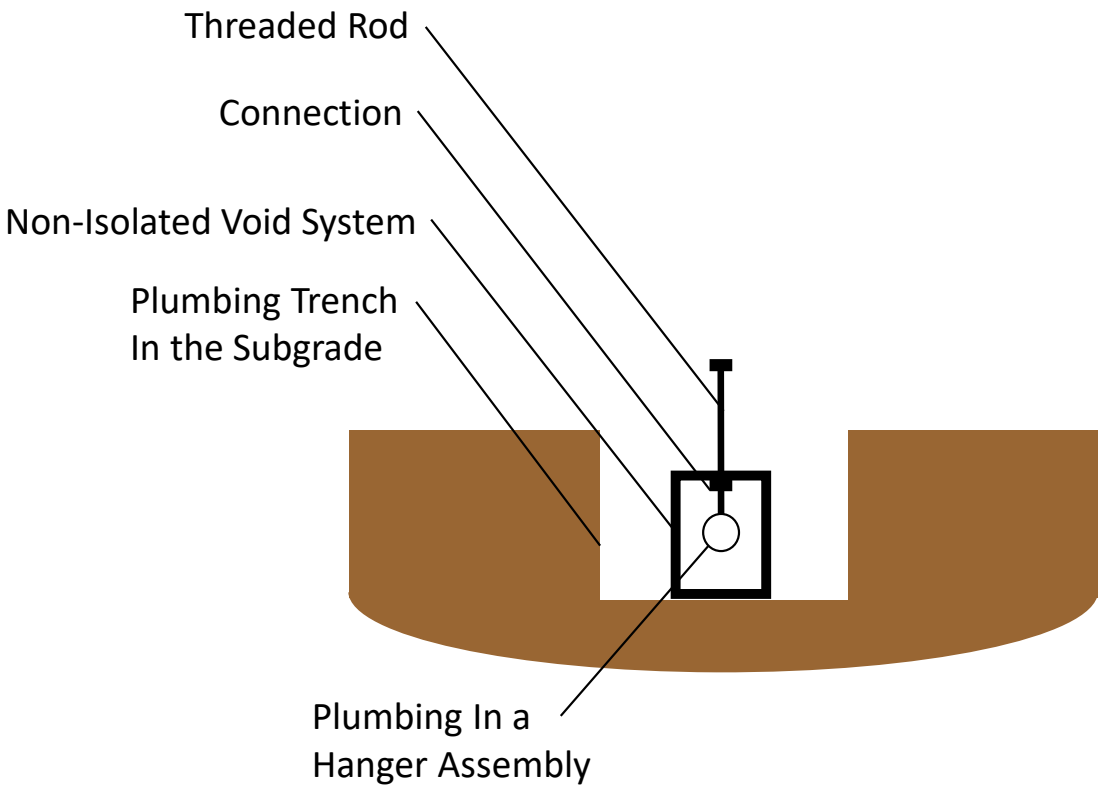
Example of Non-Isolated Plumbing Under an Isolated Slab

NOTE: THIS IS A NEGLIGENT PRACTICE



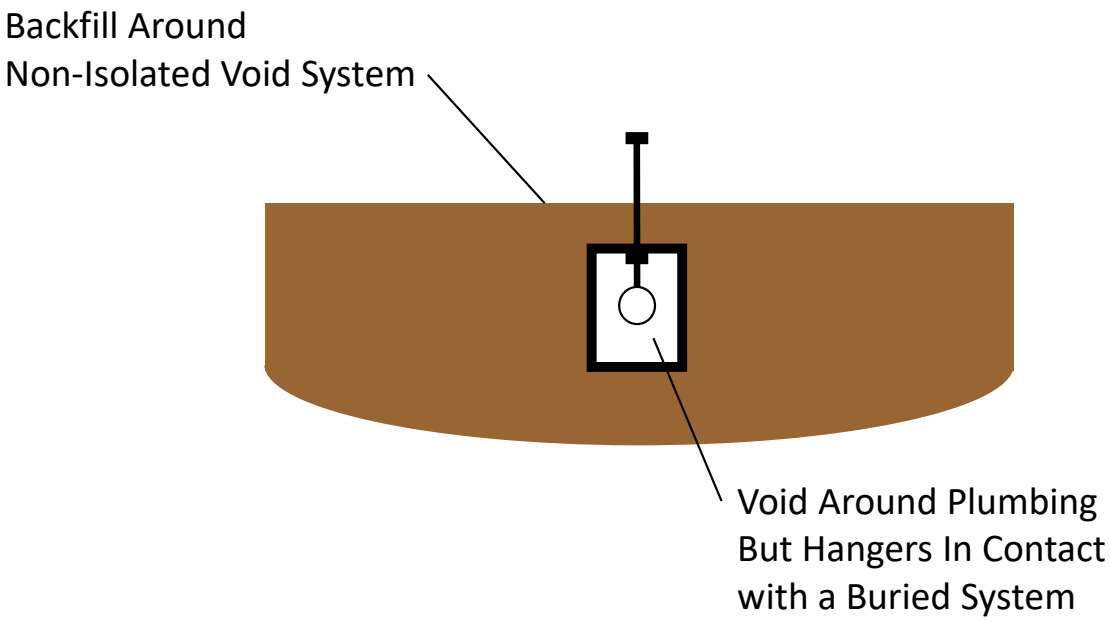
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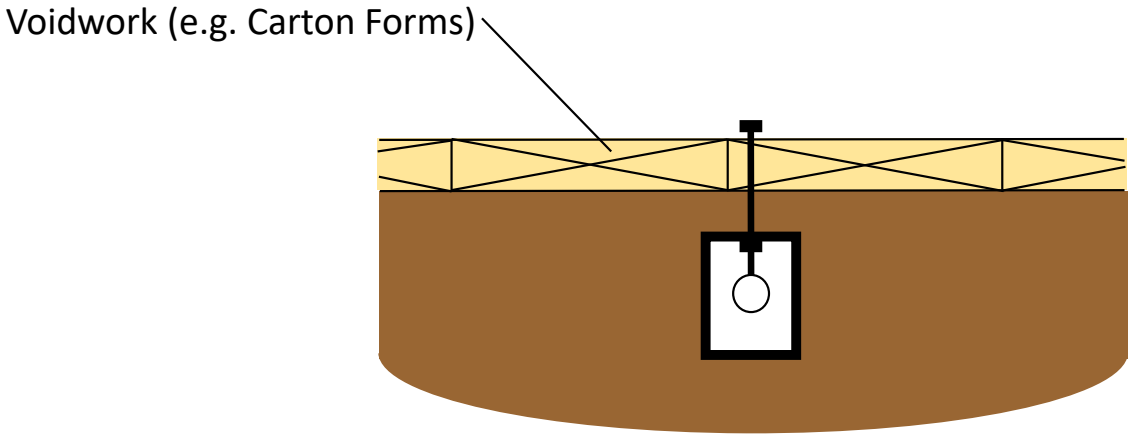
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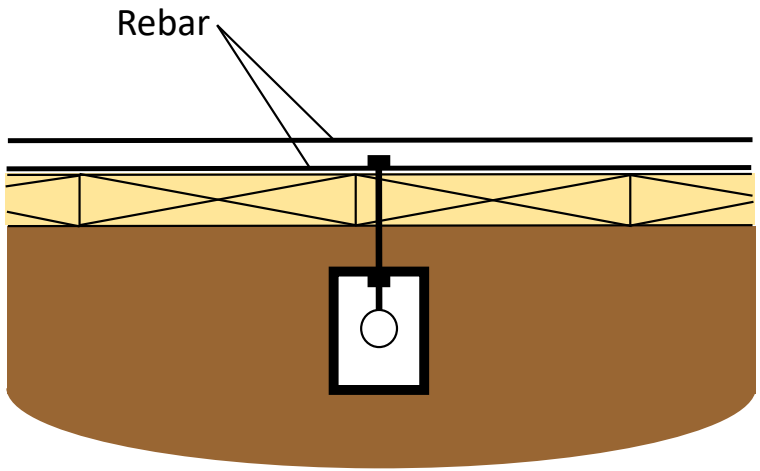
Example of Non-Isolated Plumbing Under an Isolated Slab

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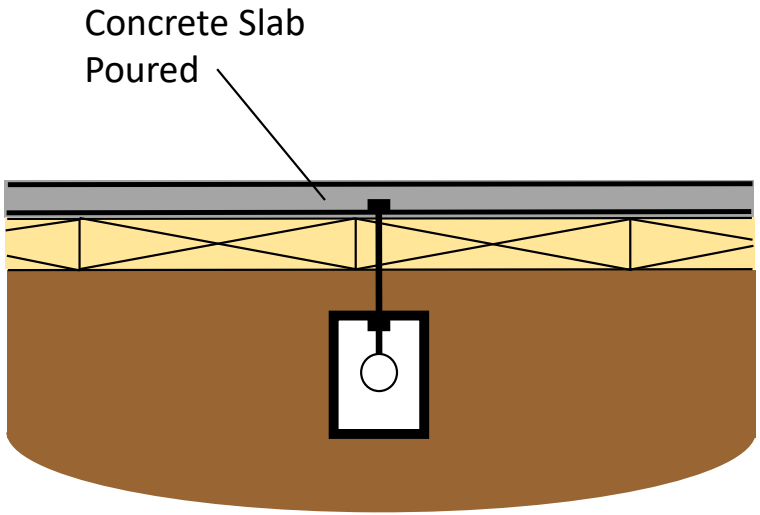
Example of Non-Isolated Plumbing Under an Isolated Slab

NOTE: THIS IS A NEGLIGENT PRACTICE



Example of Non-Isolated Plumbing Under an Isolated Slab

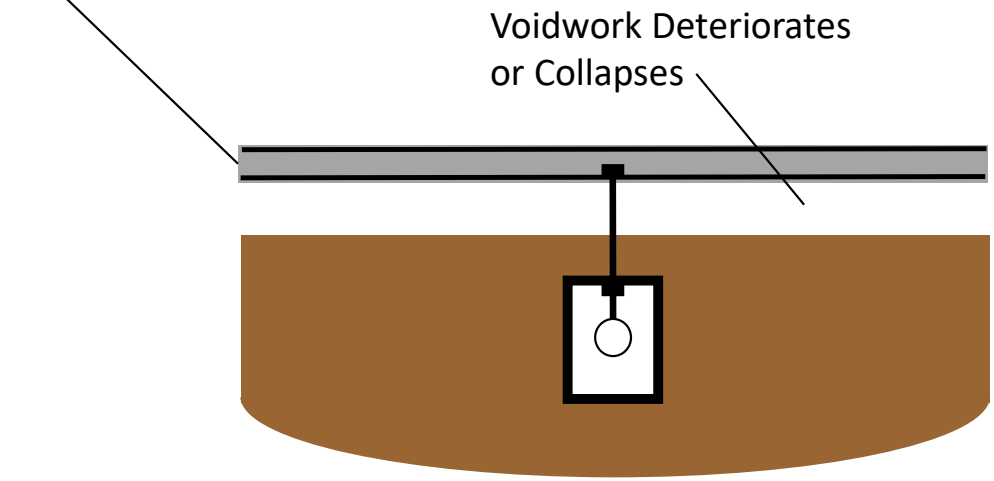
NOTE: THIS IS A NEGLIGENT PRACTICE



Example of Non-Isolated Plumbing Under an Isolated Slab

NOTE: THIS IS A NEGLIGENT PRACTICE

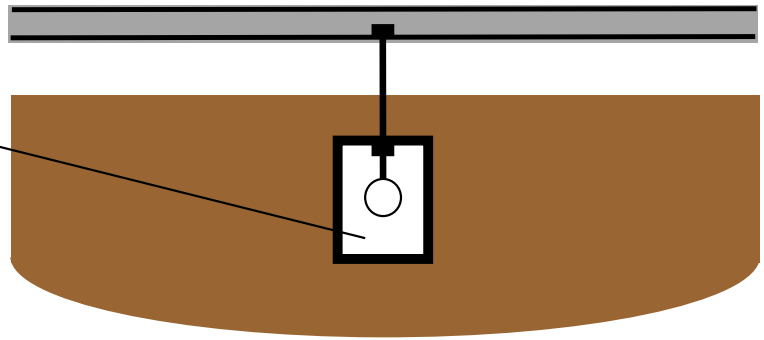
Slab is Supported by Deep Foundation Elements (e.g piers on a grid at 20 ft on center each way). The deep foundation elements are deep enough to resist expansive soil forces without moving like a non-isolated slab.



Example of Non-Isolated Plumbing Under an Isolated Slab

NOTE: THIS IS A NEGLIGENT PRACTICE

Even though non-isolated void product manufacturers may claim their product “isolates” plumbing, the void around the pipe does not protect the plumbing because the hangers are in contact with an assemblage of materials that are in contact with the subgrade that is moving up, down and laterally in non-uniform cycles.



Next 7 Slides have been extracted from the
2023 ASPE Tech Symposium Presentation titled

“Failures of Non-Isolated Plumbing in Expansive Soil”

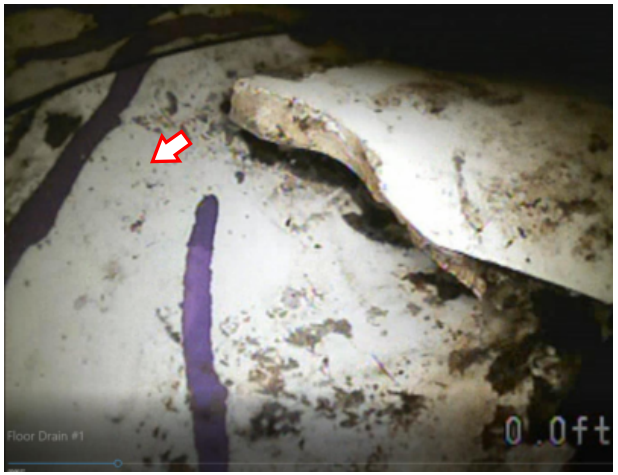
FAILURES OF NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

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FAILURES OF NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

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Example where Buried Plumbing was Installed under Slab-on-Voidwork and Plumbing Damage Occurred



Cracked P-Traps Under Floor Drains
(No Trap Seal Due to Cracks)

FAILURES OF NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

BH

Example where a Non-Isolated Void System was Installed under Slab-on-Voidwork and Plumbing Damage Occurred



Steel Mesh and Plywood Non-Isolated Void System



Hanger Rods Buckled and Displaced Plumbing

FAILURES OF NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

Example where a Non-Isolated Void System was Installed under Slab-on-Voidwork and Plumbing Damage Occurred



Plastic Panel Non-Isolated Void System and Cracked Plumbing

BH

FAILURES OF NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

JM

Example of Repairing Non-Isolated Plumbing under Slab-on-Voidwork



This repair simply replaced cracked plumbing in a non-isolated condition, so damage is expected to occur again.

FAILURES OF NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

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Example of Damage to Non-Isolated Plumbing under Slab-on-Voidwork after only 1/2” Vertical Movement



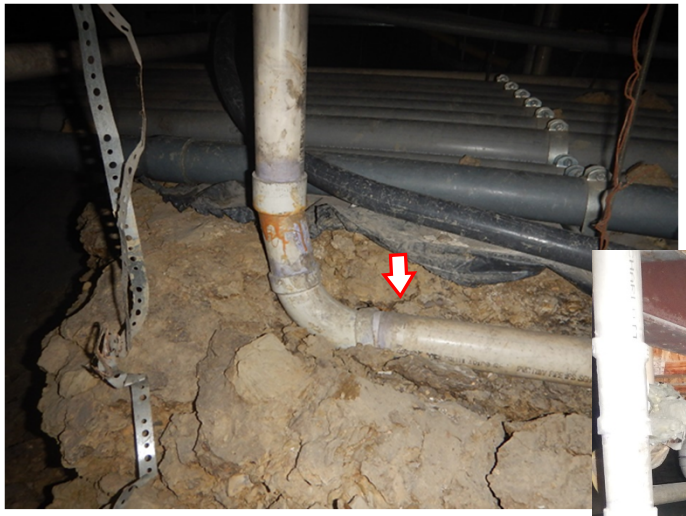
>$1M Repairs to Damaged Plumbing at a High School after 1/2” movement

Damage to Non-Isolated Plumbing under Slab-on-Voidwork is likely much more common that realized.

FAILURES OF NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

BH

Example where Non-Isolated Plumbing was Installed under Slab-on-Crawlspace and Plumbing Damage Occurred



Cracked Plumbing



Backdraining Plumbing

Litigation when Non-Isolated Plumbing was Specified under Isolated Slabs (Example: $25 M Claim with a 100,000 sf foundation)



GEOPROFESSIONAL BUSINESS ASSOCIATION

CASE HISTORY NUMBER 108

PROJECT MANAGEMENT

The Client
A national chain of senior-living facilities

The Project
A five-story senior-living facility to be constructed on an undeveloped lot

Assignment of the GBA-Member Firm
Perform a geotechnical-engineering study and provide construction-materials engineering and testing (CoMET) services during construction.

Background

The client – a national chain of senior-living facilities – contacted the GBA Member Firm about a new facility it planned to build: A five-story wood-framed structure with an underground parking garage. The Member Firm assigned the commission to a project manager who prepared an agreement-formatted proposal to perform a geotechnical-engineering study and construction-phase construction-materials engineering and testing (CoMET) services, including earthwork observation and testing, foundation-construction observation, and concrete sampling and testing, most of which was considered

The client accepted the proposal as submitted, including its $50,000-or-fee-whichever-is-higher limitation-of-liability provision.

code-required special inspections. The client's vice president for construction accepted the proposal as submitted, including its $50,000-or-fee-whichever-is-higher limitation-of-liability provision.

Late in the design process, the vice president of construction decided to reduce costs by eliminating the underground parking garage and relying, instead, on a structurally suspended slab with a crawl space beneath it. The owner and architect-led design team decided against a slab-on-grade design because the Member Firm's study revealed that the site was underlain by expansive clay soils. To protect the structurally suspended slab from underlying clay that could swell, the structural engineer specified use of void forms; cardboard forms that would support the slab during placement and then collapse once exposed to subgrade moisture. Based on a recommendation in the Member Firm's geotechnical-engineering report, the structural engineer called for a minimum void space of 12 inches.

Soon after he became aware of the client's decision to eliminate the parking garage, the Member Firm's project manager issued

The project manager issued a report addendum recommending that a particular type of form not be used.

a report addendum that he focused solely on void-form selection, recommending that a particular type of form *not* be used because of his concerns about its long-term performance. The project manager had to assume the structural engineer adopted his guidance because the architect failed to heed the explicit recommendation – included in the geotechnical-engineering

The architect failed to heed the explicit recommendation that the Member Firm review construction plans and specifications before construction began.

report – that the Member Firm review construction plans and specifications before construction began, especially because of the risks posed by expansive clays.

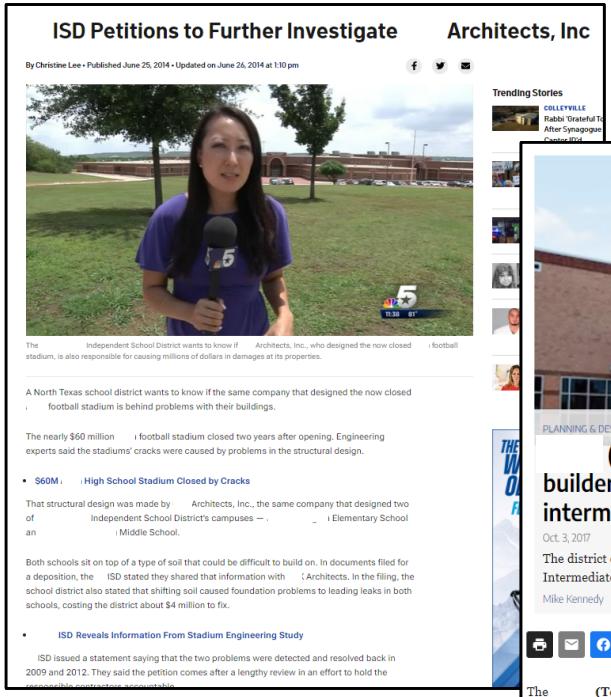
During construction, the mechanical constructor e-mailed a request for information (RFI) to all design-team members, including the GBA-Member Firm, stating that the sanitary-sewer-pipe design had to be revised because it failed to incorporate local practices for protecting buried pipes from damage caused by swelling clays.

The mechanical-engineering firm that designed the sewer lines was located in another state and was unfamiliar with local practices. Be that as it may, a month

The mechanical-engineering firm failed to respond to the RFI.

passed and the firm failed to respond to the RFI, causing the mechanical constructor – joined by the constructor-in-charge – to

PAGE 1



ISD Petitions to Further Investigate Architects, Inc

By Christine Lee • Published June 25, 2014 • Updated on June 26, 2014 at 1:10 pm

Trending Stories

The Independent School District wants to know if Architects, Inc., who designed the now closed football stadium, is also responsible for causing millions of dollars in damages at its properties.

A North Texas school district wants to know if the same company that designed the now closed football stadium is behind problems with their buildings.

The nearly $60 million football stadium closed two years after opening. Engineering experts said the stadiums' cracks were caused by problems in the structural design.

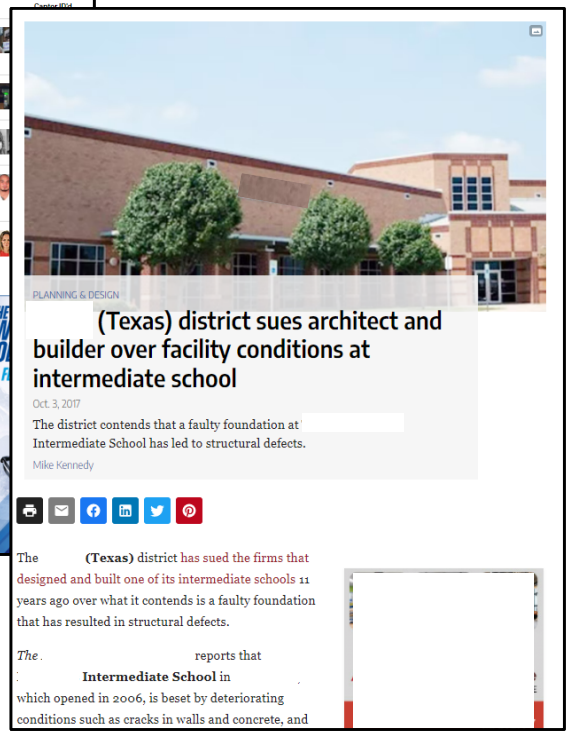
- $60M High School Stadium Closed by Cracks

That structural design was made by Architects, Inc., the same company that designed two of Independent School District's campuses — Elementary School an Middle School.

Both schools sit on top of a type of soil that could be difficult to build on. In documents filed for a deposition, the ISD stated they shared that information with Architects. In the filing, the school district also stated that shifting soil caused foundation problems to leading leaks in both schools, costing the district about $4 million to fix.

- ISD Reveals Information From Stadium Engineering Study

ISD issued a statement saying that the two problems were detected and resolved back in 2009 and 2012. They said the petition comes after a lengthy review in an effort to hold the



PLANNING & DESIGN

(Texas) district sues architect and builder over facility conditions at intermediate school

Oct. 3, 2017

The district contends that a faulty foundation at Intermediate School has led to structural defects.

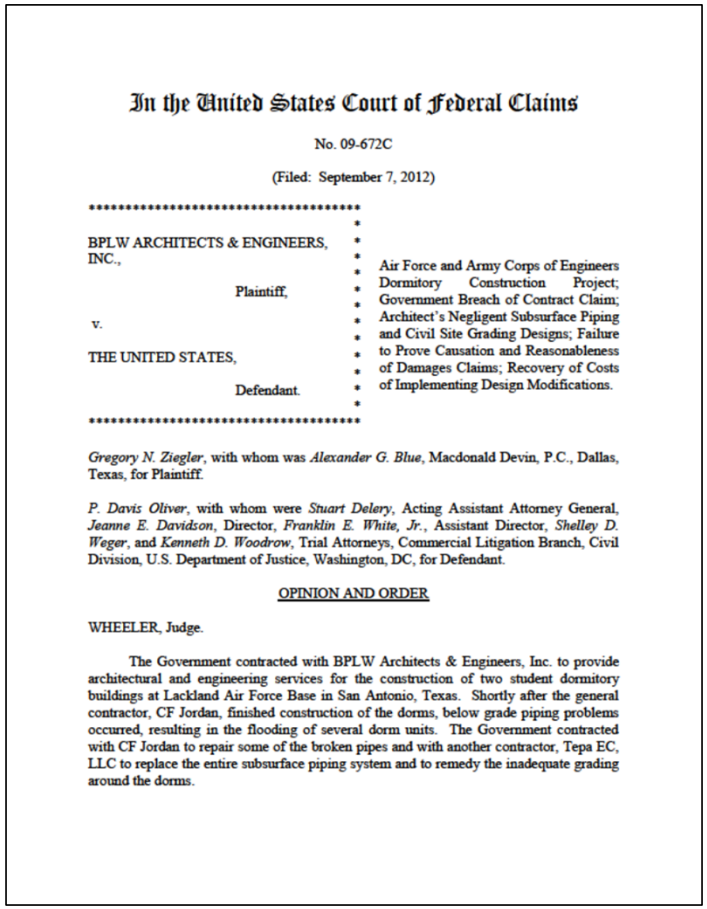
Mike Kennedy

The **(Texas)** district has sued the firms that designed and built one of its intermediate schools 11 years ago over what it contends is a faulty foundation that has resulted in structural defects.

The reports that **Intermediate School** in which opened in 2006, is beset by deteriorating conditions such as cracks in walls and concrete, and

Owners often sue multiple parties to try to maximize their award or settlement. Mechanical Engineers are the ones creating the problem, often with willful ignorance that they incorrectly believe shifts their responsibility onto other parties without those other parties realizing it.

2012 Court Ruling Found Designers Negligent when Non-Isolated Plumbing was Specified under an Isolated Slab in San Antonio, TX



In the United States Court of Federal Claims

No. 09-672C

(Filed: September 7, 2012)

BPLW ARCHITECTS & ENGINEERS, INC.,

Plaintiff,

v.

THE UNITED STATES,

Defendant.

Air Force and Army Corps of Engineers Dormitory Construction Project; Government Breach of Contract Claim; Architect's Negligent Subsurface Piping and Civil Site Grading Designs; Failure to Prove Causation and Reasonableness of Damages Claims; Recovery of Costs of Implementing Design Modifications.

Gregory N. Ziegler, with whom was *Alexander G. Blue*, Macdonald Devin, P.C., Dallas, Texas, for Plaintiff.

P. Davis Oliver, with whom were *Stuart Delery*, Acting Assistant Attorney General, *Jeanne E. Davidson*, Director, *Franklin E. White, Jr.*, Assistant Director, *Shelley D. Weger*, and *Kenneth D. Woodrow*, Trial Attorneys, Commercial Litigation Branch, Civil Division, U.S. Department of Justice, Washington, DC, for Defendant.

OPINION AND ORDER

WHEELER, Judge.

The Government contracted with BPLW Architects & Engineers, Inc. to provide architectural and engineering services for the construction of two student dormitory buildings at Lackland Air Force Base in San Antonio, Texas. Shortly after the general contractor, CF Jordan, finished construction of the dorms, below grade piping problems occurred, resulting in the flooding of several dorm units. The Government contracted with CF Jordan to repair some of the broken pipes and with another contractor, Tepa EC, LLC to replace the entire subsurface piping system and to remedy the inadequate grading around the dorms.

These organizations have all taken action against this practice:

















These Professional Engineers* have all formally presented against this practice in the last 3 years:

John Focht – Braun Intertec	Geotechnical Engineer
Don Penn – Image Engineering Group	Mechanical Engineer
Michael Lee – Wiss, Janney, Elstner Associates	Structural Engineer
Ron Podojil - R-S-C-R	Structural Engineer
Allen Grammer - Baird, Hampton & Brown	Mechanical Engineer
Tony Janish - Alpha Testing	Geotechnical Engineer
Byron Hendrix - Hendrix Consulting Engineers	Mechanical Engineer
Michael Roland - Alliance Geotechnical Group	Geotechnical Engineer
Jason Muhsmann - The Structural Alliance	Structural Engineer
Jack Tyler McFarlin – McFarlin Construction Services	Structural Engineer

*Refer to individual state board roster for specific states of licensure

References (Copies available upon request)

2024 International Plumbing Code, Sections 105.5.2 and 305.2 (commonly cited in reports by Mechanical Engineers hired by attorneys representing Owners in lawsuits related to this subject)

2024 Uniform Plumbing Code, Sections 104.4.2 and 312.2 (commonly cited in reports by Mechanical Engineers hired by attorneys representing Owners in lawsuits related to this subject)

2024 International Building Code, Sections 105.4, 1803.5.3, 1601.1 and 1610.1 (requiring plumbing, hangers and non-isolated void system soil-retaining elements be designed for the referenced lateral soil loads, including lateral swell pressures of expansive soil)

ASPE Plumbing Engineering Design Handbook, Vol 4, Chapter 6, "Hanger and Support Conditions", "Natural Environmental Conditions" (saying Mechanical Engineers should protect plumbing from the same natural phenomena, like expansive soil, when structures are designed for a natural phenomena)

Case Study 108, Geoprofessional Business Association ($25 M Claim with a 100,000 sf Foundation)

References (Copies available upon request)

P8-21 Code Provision Proposed by SEAoT to the 2024 International Plumbing Code with 14 page rationale statement, January 2021 (indicating Non-Isolated Void Systems can make matters worse than if the plumbing was simply buried, and asking the IPC Committee to confirm that IPC Section 305.2 is intended to require protection from expansive soil by approving the clarifying language SEAoT proposed; and the IPC Committee approved the clarifying language)

"Important Changes to IPC that all Geoprofessionals Should Know About"; Geoprofessional Business Association;https://www.geoprofessional.org/news/important-changes-to-ipc-that-all-geoprofessionals-should-know-about/; November 2021 (recommending Isolated Plumbing under all Isolated Foundations regardless of whether the IPC or UPC is used and regardless what edition of the plumbing code is used)

"Plumbing Code Enforcement with Expansive Soil under Slabs"; D Penn; North Texas Chapter of the International Code Council"; April 8, 2022 (recommendations to Building Officials on how to enforce IPC Section 305.2 when Mechanical Engineers attempt to get their approval without submitting the required geotechnical and structural engineering analysis. These negligent Mechanical Engineers do not know how to perform said analysis and would understand that these systems do not meet code if they did.)

"Protection of Plumbing from Expansive Soil"; D Penn; Plumbing Engineer Magazine; July 4, 2022 (where trying to justify code-compliance of any Non-Isolated Void System is called a "fool's errand")

References (Copies available upon request)

“Protection of Plumbing from Expansive Soils under Foundations”; J Focht, D Penn, M Lee; North Texas Building Professional Institute; Irving, Texas; July 13, 2022 (a detailed analysis showing why Non-Isolated Plumbing should not be specified under Isolated Slabs and why Mechanical Engineers are responsible.)

“Isolation of Plumbing Under Isolated Slabs”; R Podojil, A Grammer, T Janish; Structural Engineers Association of Texas Dallas Chapter; Dallas, Texas; November 15, 2022 (noting that Mechanical Engineers are responsible for the failures of the systems they specify when Non-Isolated Plumbing is under Isolated Slabs, and that these systems can be 100 times overstressed…not 100% overstressed…100 TIMES)

“Failures of Non-Isolated Plumbing in Expansive Soil”; B Hendrix, M Roland, J Muhsmann; American Society of Plumbing Engineers Tech Symposium; Bellevue, Washington; September 2023 (with photographs of plumbing failures in Buried Plumbing and Non-Isolated Void Systems conditions when used under Isolated Slabs)

BPLW Architects & Engineers, Inc. v. The United States in the United States Court of Federal Claims No. 09-672C; Filed: September 7, 2012 (where the Judge ruled as a finding of fact that the designers were guilty of negligence where Non-Isolated Plumbing was specified under an Isolated Slab)

References (Copies available upon request)

“A Brief History of Plumbing Codes”; R. George, Plumbing Engineer Magazine, December 31, 2019 (which provides history useful in understanding provisions like the protection requirements of the IPC and UPC today)

ASA A40.8 National Plumbing Code, 1955 Edition, Principles 9, 18, 19 & 22 (which are violated by the practice of specifying non-isolated plumbing under isolated slabs)

“Mechanical Engineers that Specify Non-Isolated Plumbing Under Isolated Slabs Today are Negligent”; J. McFarlin; Structural Engineers Association of Texas Fort Worth Chapter; Fort Worth, TX; August 14, 2024 (which summarizes why Mechanical Engineers that specify non-isolated plumbing under isolated slabs are negligent)

The Public Would Be Outraged If They Knew



Negligent Mechanical Engineers are the ones to blame.

"I cannot quantitatively defend what I've been doing and I know that I shouldn't do it because it creates a public health, safety and welfare problem but some Owners demand I continue doing it, to reduce construction cost. Plumbing Inspectors don't stop me because they don't realize this doesn't meet code."

A stated purpose of plumbing codes is to prevent exposures to sewer gases and untreated sewage.

Plumbing failures from expansive soil occur in non-isolated plumbing under isolated slabs over and over again, often in areas that are not accessible such as under Slabs-on-Voidwork, and often immediately after a repair is performed. MILLIONS OF DOLLARS, often public money, are often spent on JUST ONE FACILITY repairing plumbing when the problems are realized. However, what is worse is that the public often does not even realize the problem exists because SEWER GAS BECOMES ODORLESS with long duration low ppm exposures and with short duration high ppm exposures. People are ill but do not realize why. And, Facility Managers often misunderstand that the plumbing is breaking because of expansive soil, thinking that the plumbing installation or products must be defective.

The Dangers of Sewer Gas are Well-Known

Why is hydrogen sulfide so deadly?

- It is highly flammable and toxic, even at low concentrations.
- It is heavier than air and may travel along the ground.
- It can build up in low-lying areas, and in confined spaces (including enclosed, poorly ventilated areas, such as manure pits, sewers, manholes, and underground vaults).
- After a while at low or more quickly at high concentrations, you can no longer smell it to warn you it's there.
- It can quickly, almost immediately, overcome unprepared workers, including rescue workers.

osha.gov

Effects of Hydrogen Sulfide H2S	
PPM	**EFFECT TIME**
.00011-33	Typical background concentrations.
0.01-1.5	Odor threshold – rotten egg smell.
10	Permissible Exposure Level – 8 Hours.
20 -30	Possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness. Intense odor. Above 30ppm odor is sweet or sickeningly sweet.
50 -100	Mild Irritation - eyes, throat – 1 Hour.
100	Coughing, eye irritation, loss of smell 2-15 minute. Altered breathing, drowsiness 15-30 minutes. Throat irritation 1 hour. Symptom severity increases. Hemorrhage & Death 48 hours.
100-150	Loss of smell (olfactory fatigue or paralysis).
200-300	Significant Irritation. Marked conjunctivitis & respiratory tract – 1 Hour. Pulmonary edema may occur from prolonged exposure 48 hours.
500 - 700	Staggering, unconsciousness in 5 minutes. Serious eye damage, 30 minutes. **Death 30-60 minutes.**
700-1000	Rapid unconsciousness, "knockdown" or immediate collapse 1 to 2 breaths. Breathing stops. **Death within minutes.**
>1000	**Nearly instant Death.**

This material was produced under grant number SH-27664-SH5 from the Occupational Safety and Health Administration, U.S. Department of Labor. It does not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Grain Handling Safety Coalition
www.grainsafety.org

News Reports of Illness from Sewer Gas

Sewer gas leak hospitalizes four high school students

9/20/2023

(UI) – According to Shore News Network, four high school students from | High School in \ have been hospitalized due to exposure to a hazardous odor.



On Monday, these students reported feeling unwell after detecting an unusual smell, and they were swiftly transported to a local hospital. Fortunately, their condition is stable.

Investigations have revealed that the mysterious odor is hydrogen sulfide, commonly known as sewer gas. This gas is notorious for its flammable and toxic characteristics and tends to accumulate in low and enclosed spaces because it is denser than air.

Inhaling sewer gas can lead to a range of health complications, from mild issues like headaches and eye irritation to severe outcomes such as unconsciousness or even death.

Fire and EMS crews are currently on-site, working to mitigate the situation at the affected school and ensure the safety of the students and staff.

This story was originally published by Shore News Network.

Bacteria When Sewage Backs Up

Bacteria	Concentration in Sewage[a] (per 100mL)	Disease[b]	Effects[b]	Infective Dose[c,d]
Campylo-bacter	3,700 -100,000	Gastroenteritis	Vomiting, diarrhea	10^2 - 10^6
Pathogenic *E. coli*	30,000 - 10,000,000	Gastroenteritis	Vomiting, diarrhea, Hemolytic Uremic syndrome (HUS), death in susceptible populations	10^6 - 10^8
Salmonella	0.2 - 11,000	Salmonellosis	Diarrhea, dehydration	10^4 - 10^7
S. typhi		Typhoid fever	High fever, diarrhea, ulceration of the small intestine	10^3 - 10^7
Shigella	0.1 - 1,000	Shigellosis	Bacillary dysentery	10^1 - 10^2
Vibrio cholera		Cholera	Extremely heavy diarrhea, dehydration	10^3 - 10^8
Vibrio non-cholera	10 - 10,000	Gastroenteritis	Extremely heavy diarrhea, nausea, vomiting	10^2 - 10^6
Yersinia		Yersinosis	Diarrhea	10^6

[a] Details in Appendix I
[b] EPA 1999C
[c] Yates and Gerba 1998
[d] Lue-Hing 2003

Table 6.1

Common Pathogenic Bacteria Present in Sewage

Infective dose is defined as the number of pathogens required to cause subclinical infection. Infective doses are typically given as ranges, as the actual infective dose depends on the pathogen strain and an individual's health condition.

Viruses When Sewage Backs Up

Table 6.2

Common Enteric Viruses Present in Sewage

Enteric viruses are typically very infectious: 1-10 virus particles can cause infection.

Virus Group	Concentration in Sewage[a] (per 100mL)	Disease[b]	Effects [b]
Adenovirus	10 - 10,000	Respiratory disease, gastroenteritis, pneumonia	Various effects
Astrovirus		Gastroenteritis	Vomiting, diarrhea
Noraviruses (includes Norwalk-like viruses)		Gastroenteritis	Vomiting, diarrhea
Echovirus		Hepatitis, respiratory infection, aseptic meningitis	Various effects, including liver disease
Enterovirus (includes polio, encephalitis, conjunctivitis, and coxsackie viruses)	0.05 - 100,000	Gastroenteritis, heart anomalies, aseptic meningitis, polio	Various effects
Reovirus	0.1 - 125	Gastroenteritis	Vomiting, diarrhea
Rotavirus	0.1 - 85,000	Gastroenteritis	Vomiting, diarrhea

[a] Details in Appendix I
[b] EPA 1999C
[c] Yates and Gerba 1998
[d] Lue-Hing 2003

Protozoa When Sewage Backs Up

Table 6.3

Common Parasitic Protozoa Present in Sewage

Parasitic protozoa have very low infective doses, which makes their presence in CSO and SSO discharges an important public health concern.

Parasitic Protozoa	Concentration in Sewage[a] (per L)	Disease[b]	Effects[b]	Infective Dose[c]
Cryptosporidium	3 - 13,700	Crypto-sporidiosis	Diarrhea	1 - 150
Entamoeba	4 - 52	Amedbiasis (amoebic dysentery)	Prolonged diarrhea with bleeding, abscess of the liver and small intestine	10 - 20
Giardia	2 - 200,000	Giardiasis	Mild to severe diarrhea, nausea, indigestion	10 - 100

[a] Details in Appendix I
[b] EPA 1999C
[c] Yates and Gerba 1998

Next 19 Slides have been extracted from the
2021 North Texas BPI Presentation titled

“Protection of Plumbing from Expansive Soil Under Foundations”

The original 3 hour presentation has many more slides on failure modes of non-isolated plumbing under isolated slabs.

FOCUS:

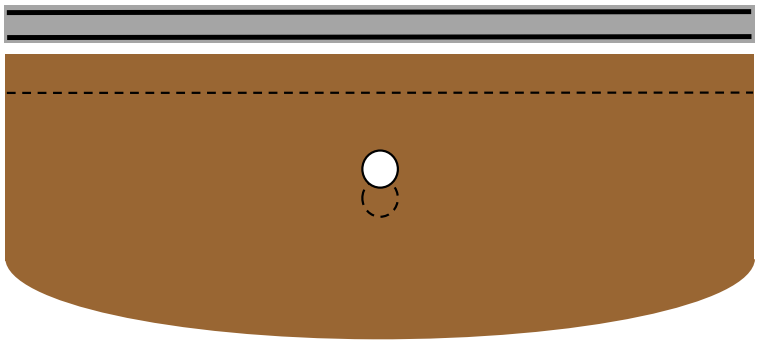
NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

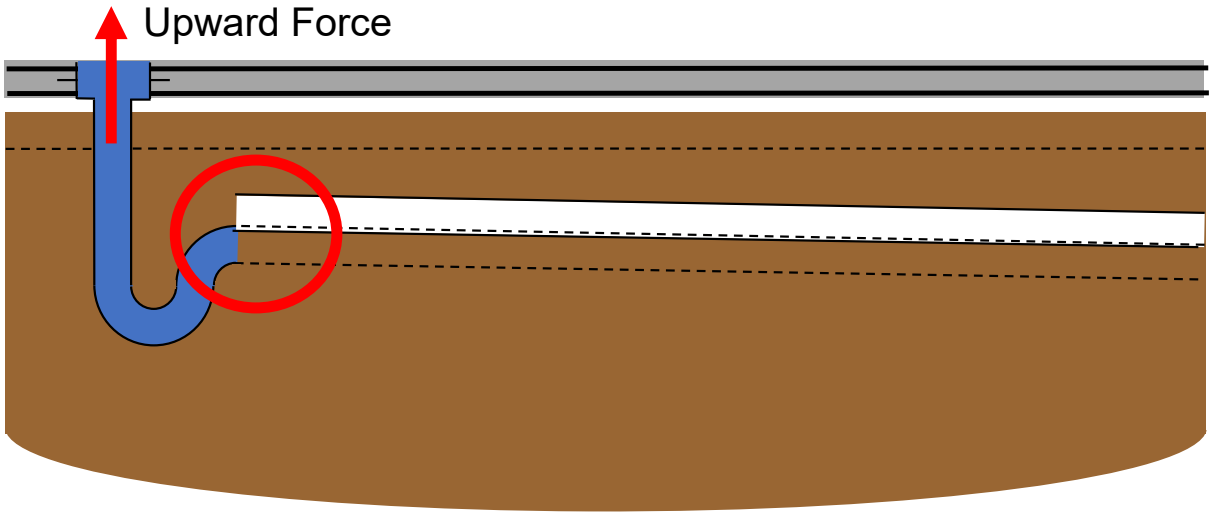
BURIED PLUMBING
LOAD CASE EXAMPLES

JF

General Under-Slab Swelling

Plumbing that is not designed to receive soil-induced loads can become unfunctional, crack, and become exposed to the subgrade.





FOCUS:

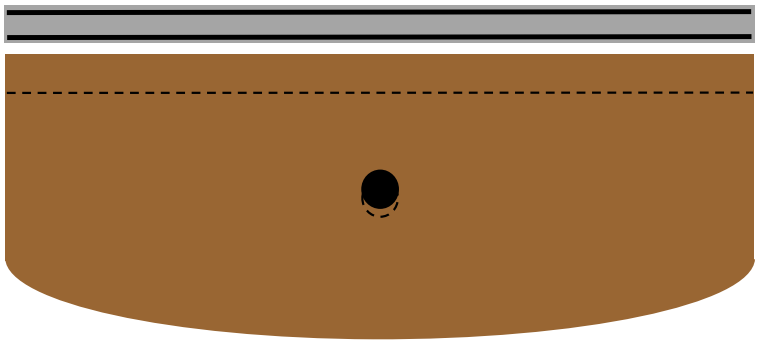
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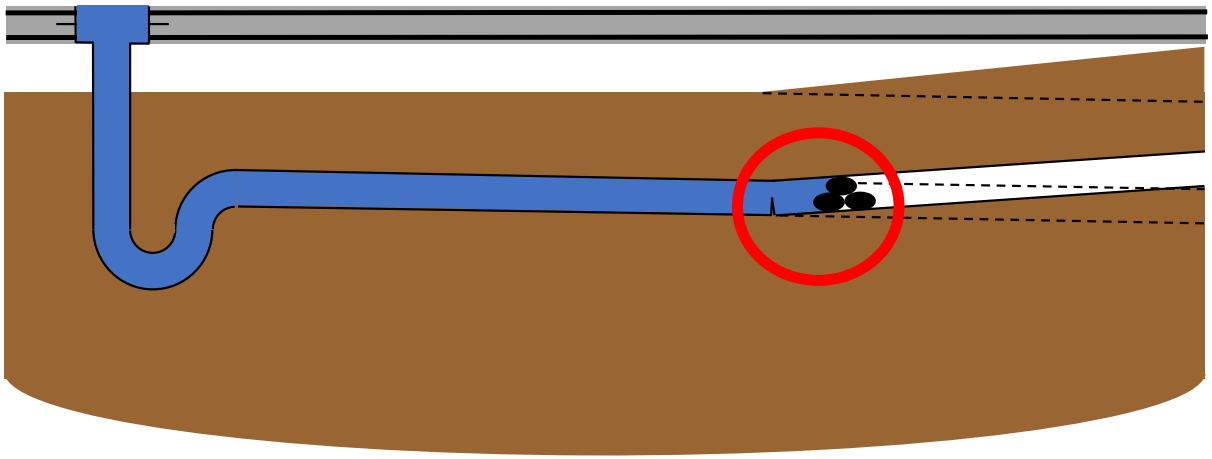
BURIED PLUMBING
LOAD CASE EXAMPLES

JF

Perimeter Under-Slab Swelling

Plumbing that is not designed to receive soil-induced loads can become unfunctional, crack, and become exposed to the subgrade.



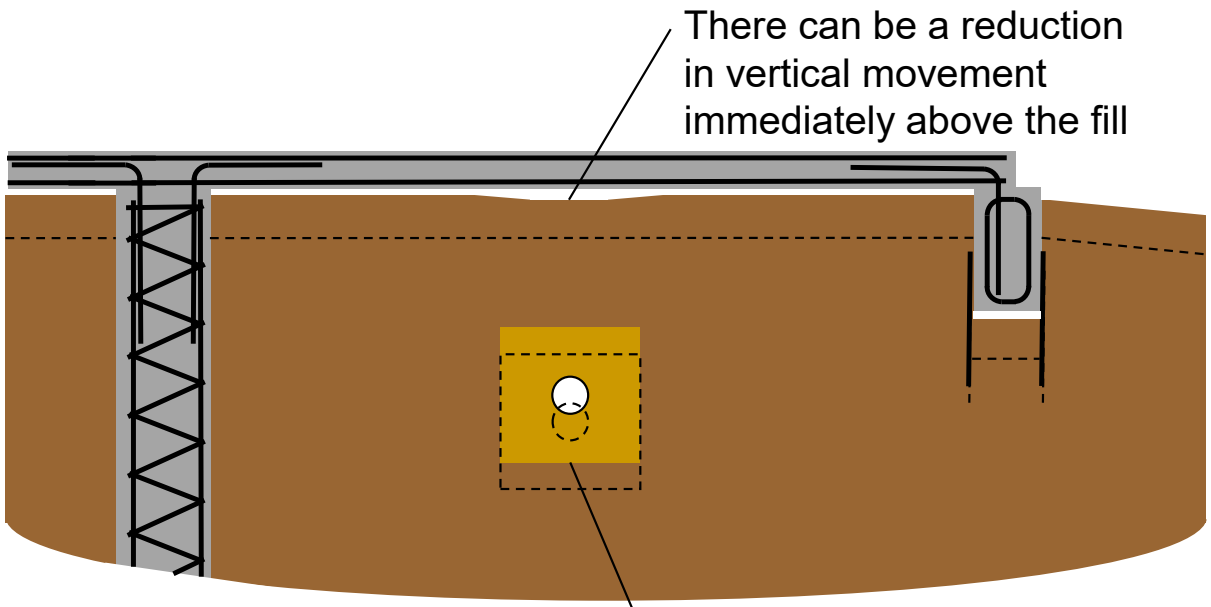


FOCUS:

NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

JF

Non-Expansive Fill in the Active Zone



FOCUS:

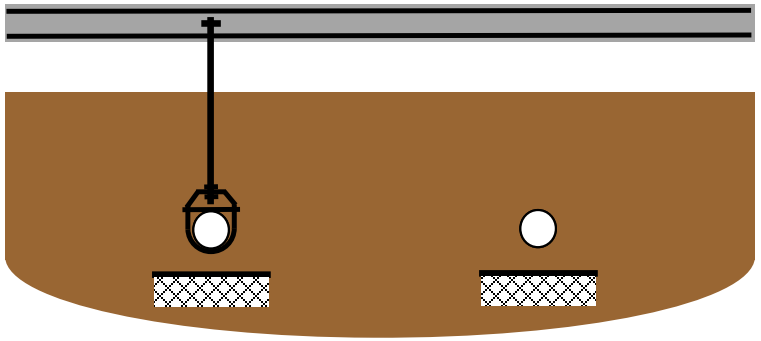
NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

NON-ISOLATED VOID SYSTEMS

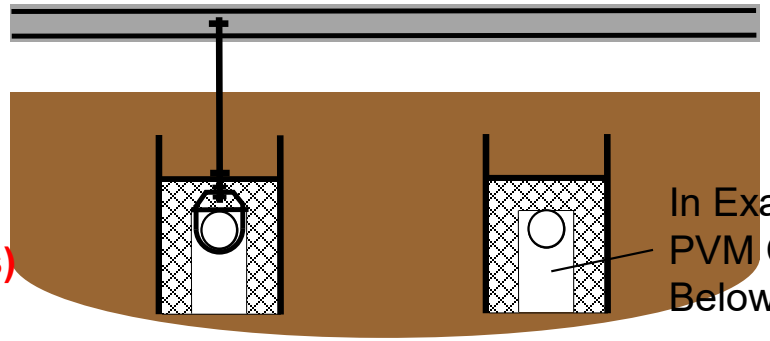
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Examples

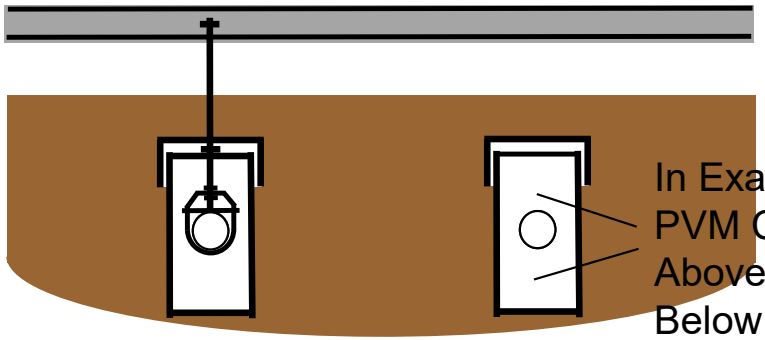
Mesh & Plywood Under Plumbing



Mesh & Plywood Above Plumbing
(Similar to above and below examples)



Plastic Side Panels & Crossbars



FOCUS:

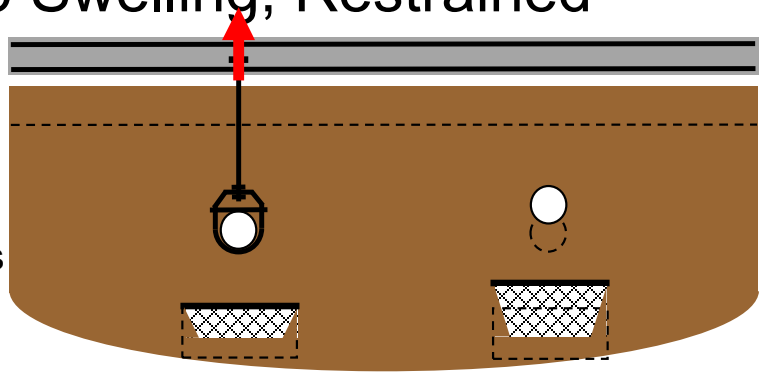
NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

NON-ISOLATED VOID SYSTEMS
LOAD CASE EXAMPLES

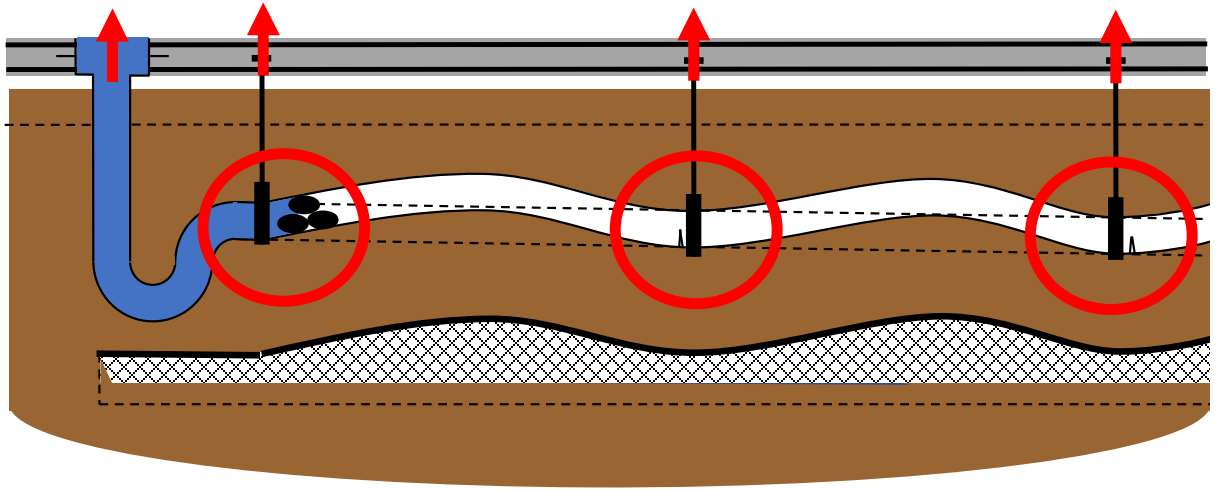
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MESH & PLYWOOD UNDER PLUMBING
Gen. Under-Slab Swelling, Restrained

Void Systems that do not isolate plumbing can transfer loads. Plumbing that is not designed to receive soil-induced loads can become unfunctional, crack, and become exposed to the subgrade.



Forces on slabs can cause damage too.



FOCUS:

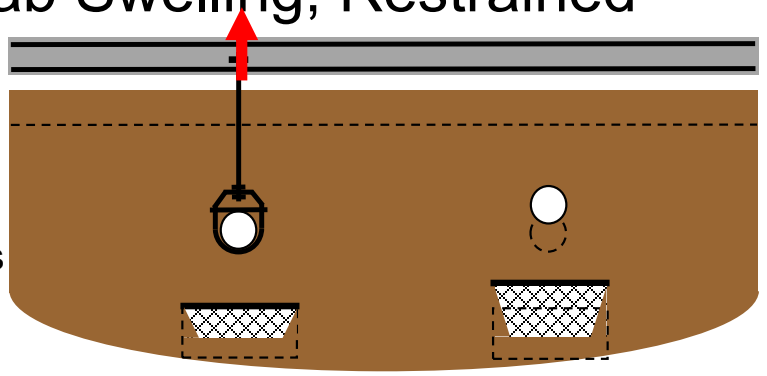
NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

NON-ISOLATED VOID SYSTEMS
LOAD CASE EXAMPLES

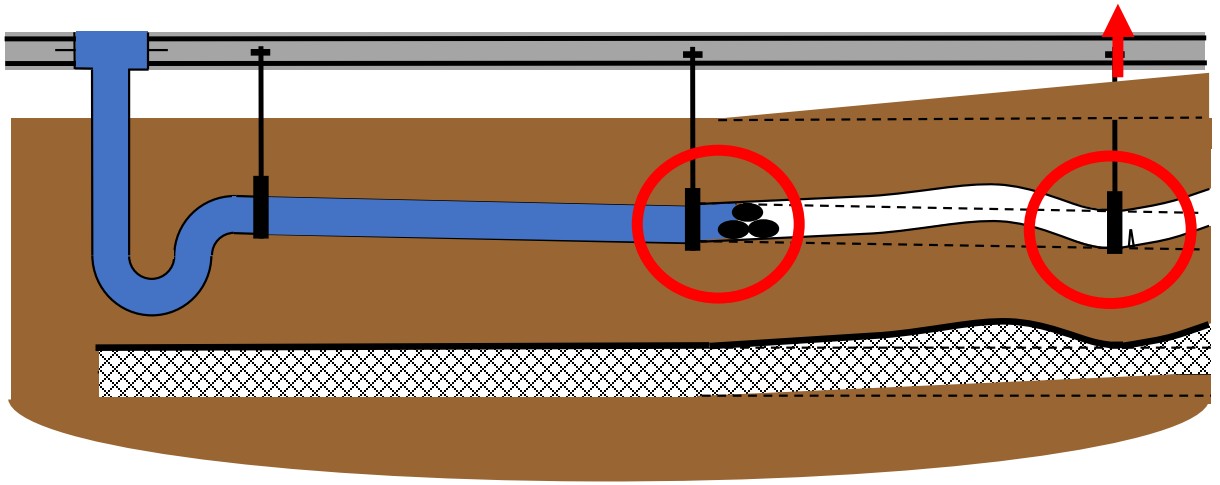
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MESH & PLYWOOD UNDER PLUMBING
Perim. Under-Slab Swelling, Restrained

Void Systems that do not isolate plumbing can transfer loads. Plumbing that is not designed to receive soil-induced loads can become unfunctional, crack, and become exposed to the subgrade.



Forces on slabs can cause damage too.



FOCUS:

NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

NON-ISOLATED VOID SYSTEMS

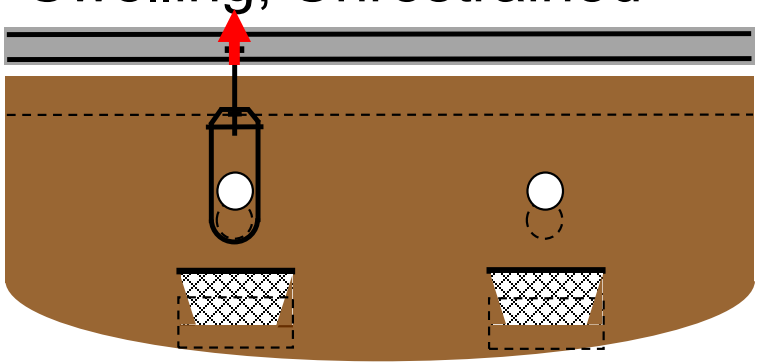
LOAD CASE EXAMPLES

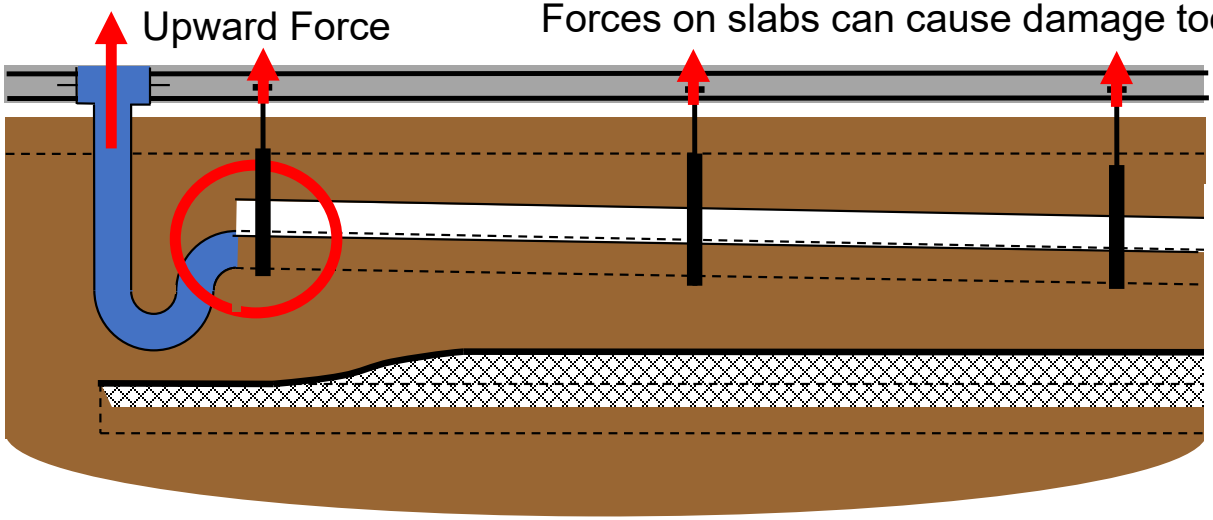
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MESH & PLYWOOD UNDER PLUMBING

Gen. Under-Slab Swelling, Unrestrained

Plumbing that is not designed to receive soil-induced loads can become unfunctional, crack, and become exposed to the subgrade.





FOCUS:

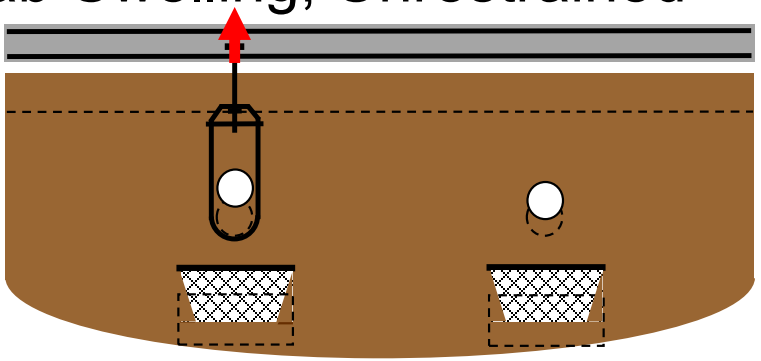
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NON-ISOLATED VOID SYSTEMS
LOAD CASE EXAMPLES

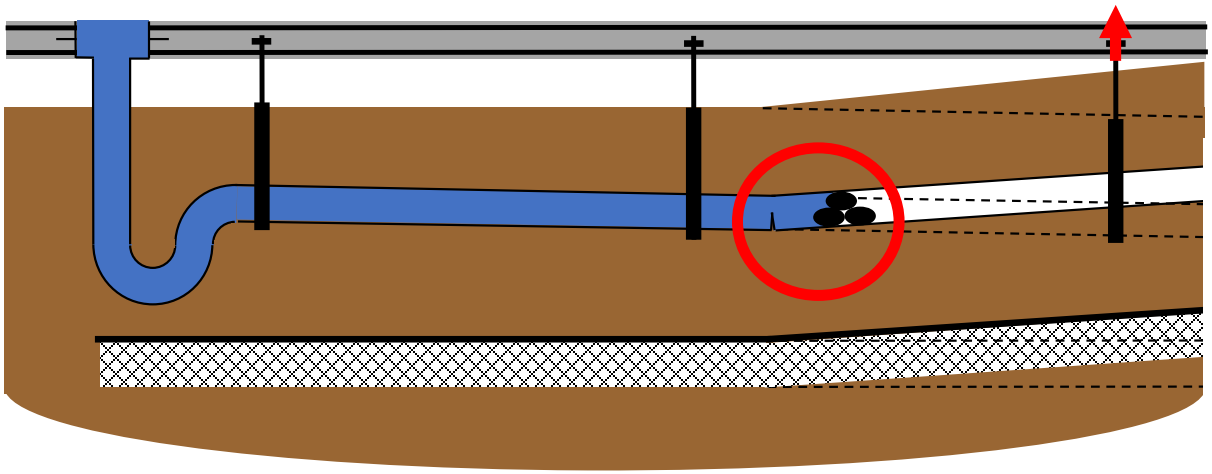
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MESH & PLYWOOD UNDER PLUMBING
Perim. Under-Slab Swelling, Unrestrained

Plumbing that is not designed to receive soil-induced loads can become unfunctional, crack, and become exposed to the subgrade.



Forces on slabs can cause damage too.



FOCUS:

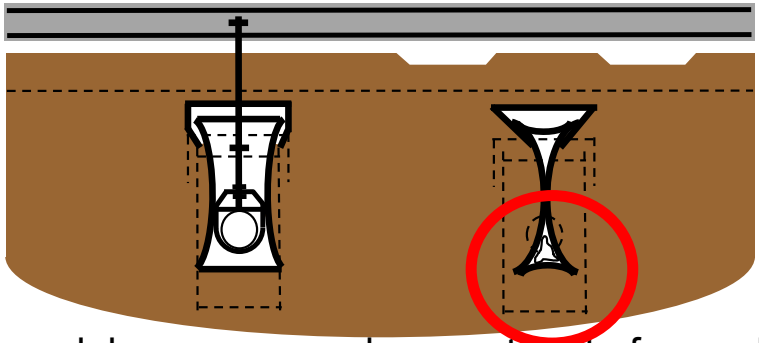
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NON-ISOLATED VOID SYSTEMS
LOAD CASE EXAMPLES

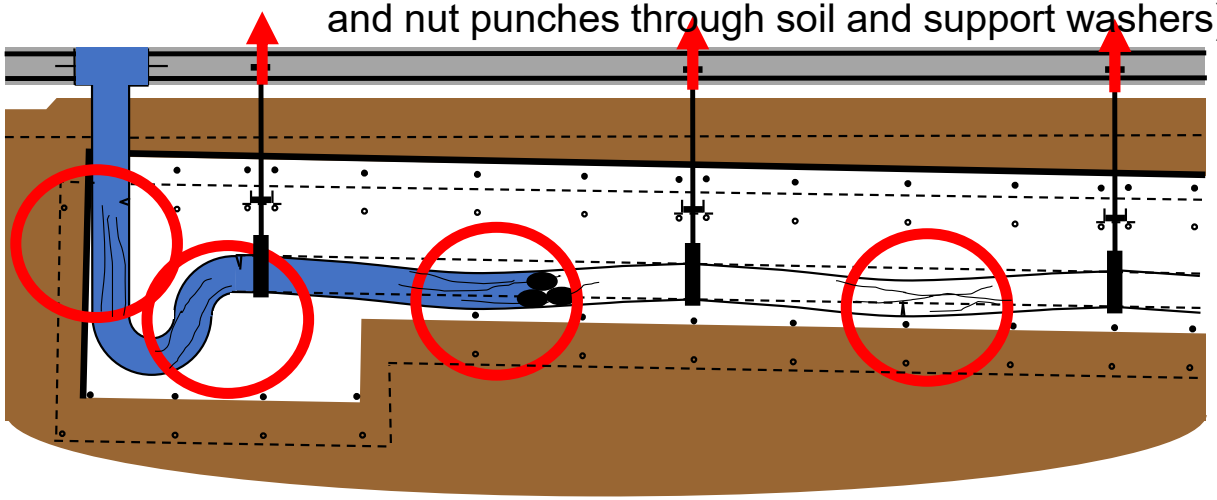
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PLASTIC SIDE PANELS AND CROSSBARS
Gen. Swelling, No Rod Buckling

Plumbing that is not designed to receive soil-induced loads can become unfunctional, crack, and become exposed to the subgrade.



Forces on slabs can cause damage too (before rod and nut punches through soil and support washers).



FOCUS:

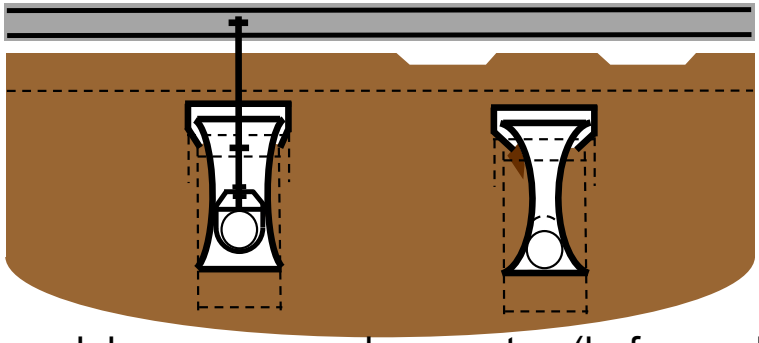
NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

NON-ISOLATED VOID SYSTEMS
LOAD CASE EXAMPLES

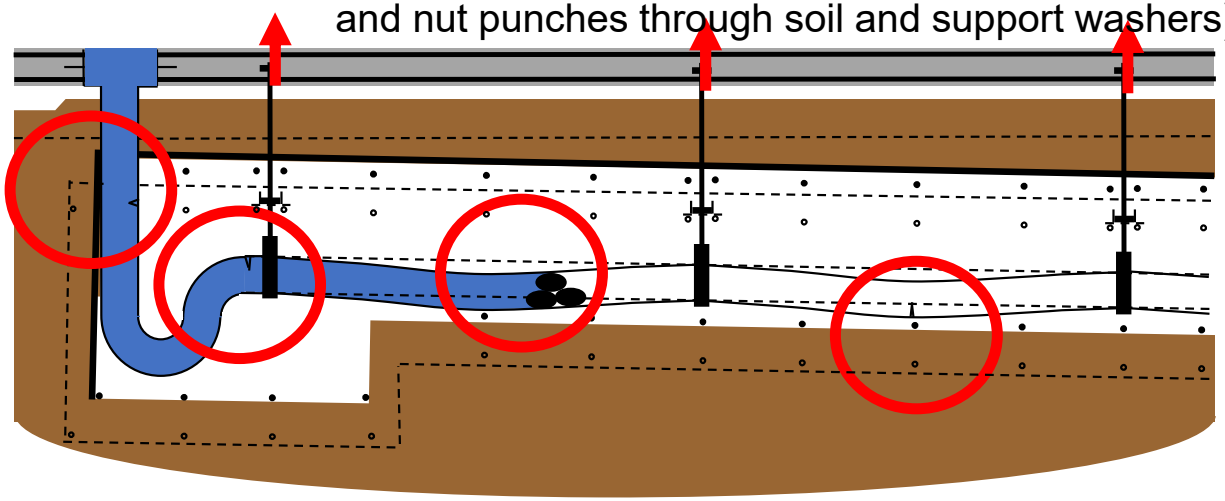
DP

PLASTIC SIDE PANELS AND CROSSBARS
Gen. Swelling, No Rod/Crossbar Buckling

Plumbing that is not designed to receive soil-induced loads can become unfunctional, crack, and become exposed to the subgrade.



Forces on slabs can cause damage too (before rod and nut punches through soil and support washers).



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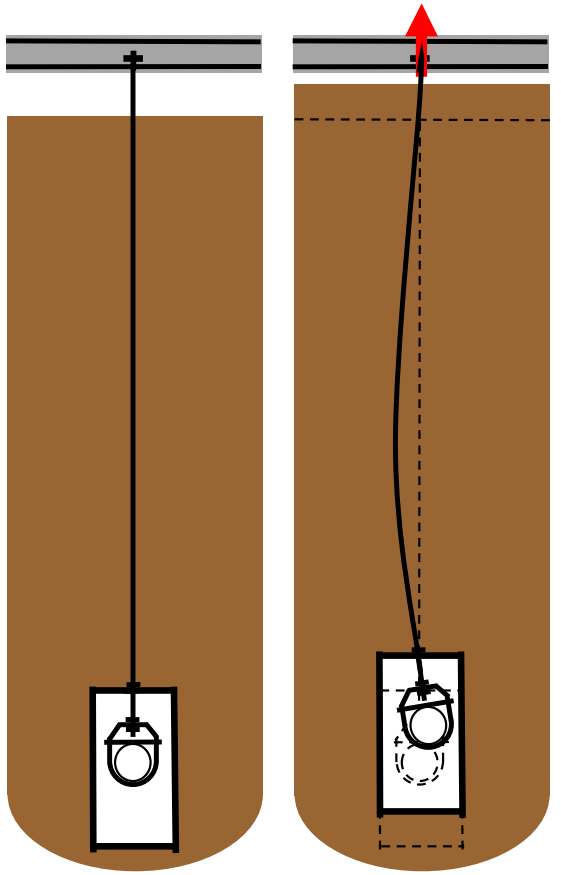
NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

NON-ISOLATED VOID SYSTEMS

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PIPE LIFT BY SOIL RETENTION SYSTEMS

If soil loads lift a soil retention system that is restrained by a nut on top of the system which transfers load to a threaded rod, there will be an initial force pushing up on the slab. The rod can begin to buckle (Examples: larger swell forces and/or longer rods, especially rods with tall voidspaces and/or rods in intentionally uncompacted loose fill which may not sufficiently brace the rod from buckling), which would cause the pipe to lift. If the nut punches through the pipe hanger support element(s) of a soil retention system and punches through any soil friction on the threaded rod before buckling, the system might rise without lifting the pipe further.



As Installed

After Swelling (If no “punch-through”)

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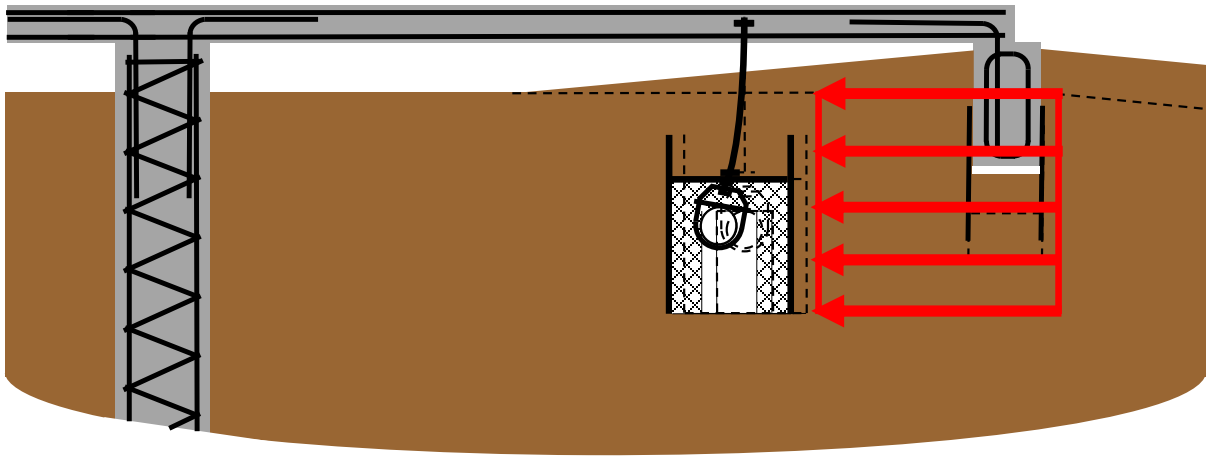
NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

NON-ISOLATED VOID SYSTEMS

JF

NET HORIZONTAL FORCES

Soil swelling on one side of a Non-Isolated Void System can create net horizontal forces that push Non-Isolated Void Systems and damage plumbing. As an example, this could occur where plumbing runs near and parallel to an exterior grade beam and then exterior soil swells after being exposed to moisture.



FOCUS:

NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

NON-ISOLATED VOID SYSTEMS

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SWELL/SHRINK CYCLE DEFORMATIONS

Designers need to also carefully consider the effects of swell/shrink cycles on the deformed shape of non-isolated void systems.

As an example for plastic side panels and crossbars, in a shrinkage condition, any crossbars that bend upon contact with clevises or pipes (causing crossbar deflection) will have an initial mid-span deflection that can significantly reduce the axial buckling capacity of the crossbar in a swell condition, especially if there is “plastic” deformation (in this case referring to “plastic” as the opposite of elastic in material behavior).

Furthermore, cyclical stress reversals typically lead to failures due to material fatigue at significantly lower stresses than at initial conditions.

FOCUS:

NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

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DELEGATED DESIGN OF NON-ISOLATED VOID SYSTEMS

A design professional specifying a non-isolated void system should not attempt to specify that the design of the system be delegated during construction (e.g. with shop drawings bearing the seal of a Professional Engineer). It is the responsibility of the specifying professional to sufficiently define the scope of the Delegated Design Engineer. Simply specifying that the shop drawings be sealed does not define any responsibility for the Delegated Design Engineer. Furthermore, it is not appropriate for design professionals to try to divest their responsibility with vaguely defined and broad specification language for this complex multi-disciplinary issue where data in the industry is sorely lacking and other design professionals on a project need to coordinate scopes with this task. Therefore, for all of the reasons stated in this presentation and more, it is not feasible for a Mechanical Engineer to properly specify all of the multi-disciplinary criteria and collaboration required for any specific non-isolated void system.

FOCUS:

NON-ISOLATED PLUMBING UNDER ISOLATED SLABS

DP

RECOMMENDATION

We recommend Mechanical Engineers **immediately cease and desist the practice of permitting Non-Isolated Plumbing (Buried Plumbing or Non-Isolated Void Systems) under Slab-on-Voidwork** foundations, regardless of whether the IPC or UPC applies or whatever edition applies, whatever the geotechnical engineer estimates to be the probability of movement occurring, whatever the building official will allow, and however hard the owner demands to reduce the initial cost of construction and claims they will accept the risks of damage that would requiring extensive and repeated maintenance.

We recommend Mechanical Engineers **immediately begin complying with the provisions already approved by ICC for the 2024 IPC** (provided in this presentation) for protection of plumbing from expansive soil, which is also recommended by the Geoprofessional Business Association:

Non-Isolated Plumbing is allowed under Non-Isolated Slabs

Isolated Plumbing is required under Isolated Slabs

UPCOMING 2024 IPC

ICC INTERNATIONAL CODE COUNCIL®

DP

International Plumbing Code
New Language in the 2024 Edition

Explicitly requires protection of plumbing from expansive soil and defines when expansive soil is present.

Allows buried plumbing under Slabs-on-Ground.

Requires complete isolation of plumbing under Slab-on-Crawlspace and Slab-on-Voidwork: "***It shall not be permitted for the plumbing, hangers and supports below the slab or below the framing to be in contact with soil or any assemblage of materials that is in contact with soil within the active zone***."

Exception 1 allows buried pipe for drainage of crawl spaces

Exception 2 allows attachment to piers if the plumbing, hangers and supports are otherwise isolated.

305.8 Expansive Soil. Where expansive soil is identified under buildings in accordance with Section 1803.5.3 of the International Building Code, but not removed in accordance with Section 1808.6.3 of the International Building Code, plumbing shall be protected in accordance with Section 305.8.1 or 305.8.2.

305.8.1 Non-Isolated Foundations. Under foundations with slabs that are structurally supported by a subgrade, it shall be permitted for plumbing to be buried.

305.8.2 Isolated Foundations. Under foundations with a slab or framing that structurally spans over an under-floor space which isolates the slab or framing from the effects of expansive soil swelling and shrinking in accordance with Section 1808.6.1 of the International Building Code, the plumbing shall be suspended so that plumbing, hangers and supports are isolated, by a voidspace, from the effects of expansive soil swelling and shrinking.

Exception: It shall be permitted for plumbing to be buried if the plumbing provides drainage of an under-floor space.

To protect the voidspace, soil shall be sloped, benched or retained in accordance with an approved design methodology.

It shall not be permitted for the plumbing, hangers and supports below the slab or below the framing to be in contact with soil or any assemblage of materials that is in contact with soil within the active zone. It shall not be permitted for a slab and plumbing to be lifted as an assembly to create the voidspace unless the under-floor space is a crawlspace with access to allow inspection of plumbing after lifting.

Exception: It shall be permitted for the piping, fittings, hangers, and supports below the slab or below the framing to be in contact with structural elements of the foundation that are designed to resist the effects of expansive soil swelling and shrinking in accordance with Section 1808.6.1 of the International Building Code.

Organic materials subject to decay shall not be used for hangers, supports and soil retention systems. Materials subject to corrosion shall not be used for hangers, supports and soil retention systems unless protected in an approved manner.

Where plumbing transitions to a buried condition beyond the perimeter of the foundation, an adequately flexible expansion joint shall be provided in the plumbing system to accommodate the effects of expansive soil swelling and shrinking.

Next 1 Slide has been extracted from the
2022 SEAoT Dallas Presentation Titled

“Isolation of Plumbing Under Isolated Slabs”

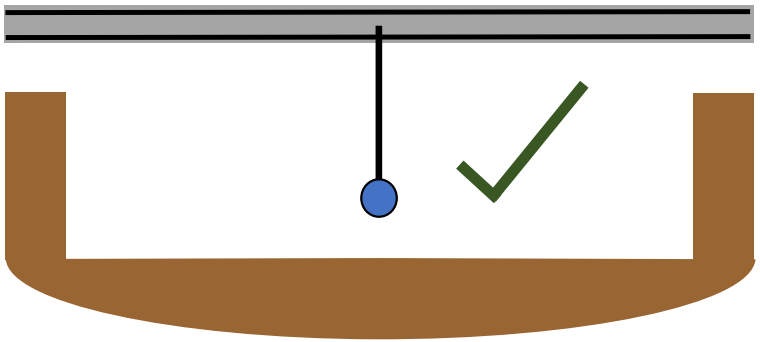
TASK #1

KNOW WHAT ISOLATED PLUMBING IS

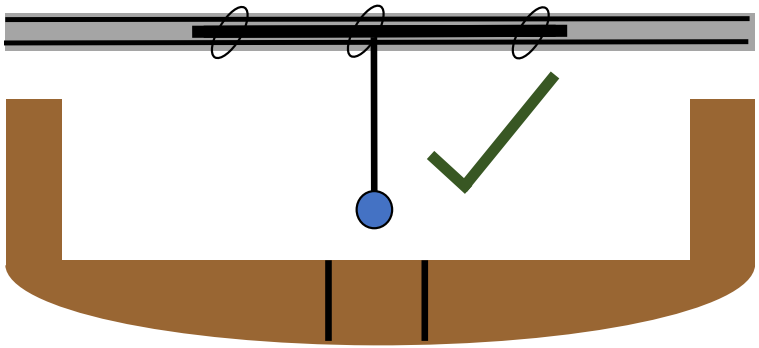
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Isolated Slabs with **Isolated Plumbing**

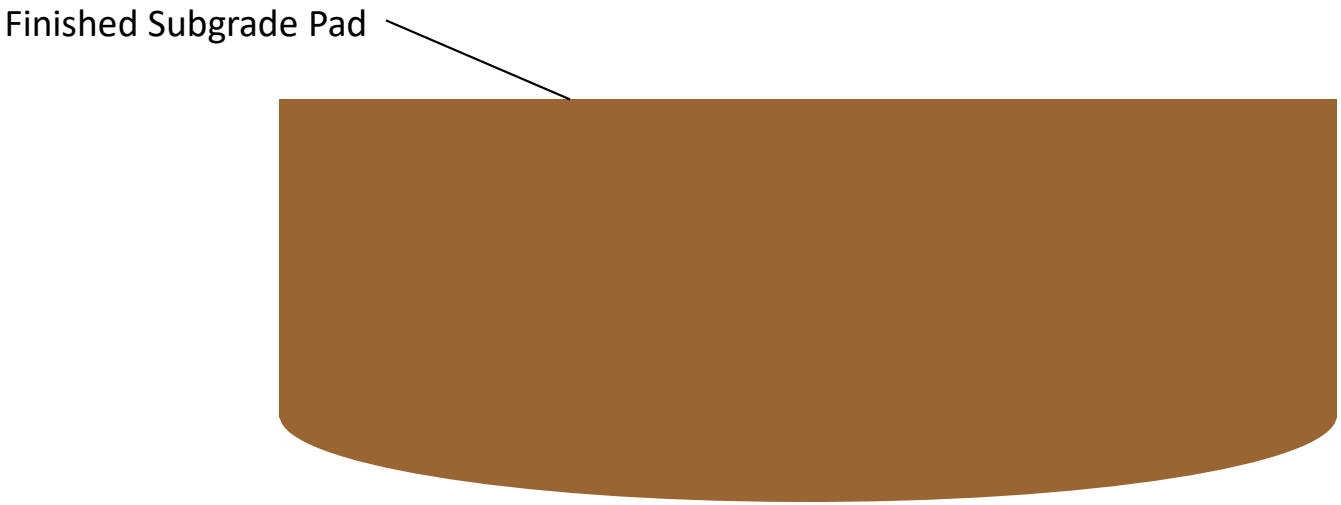
Post-Installed



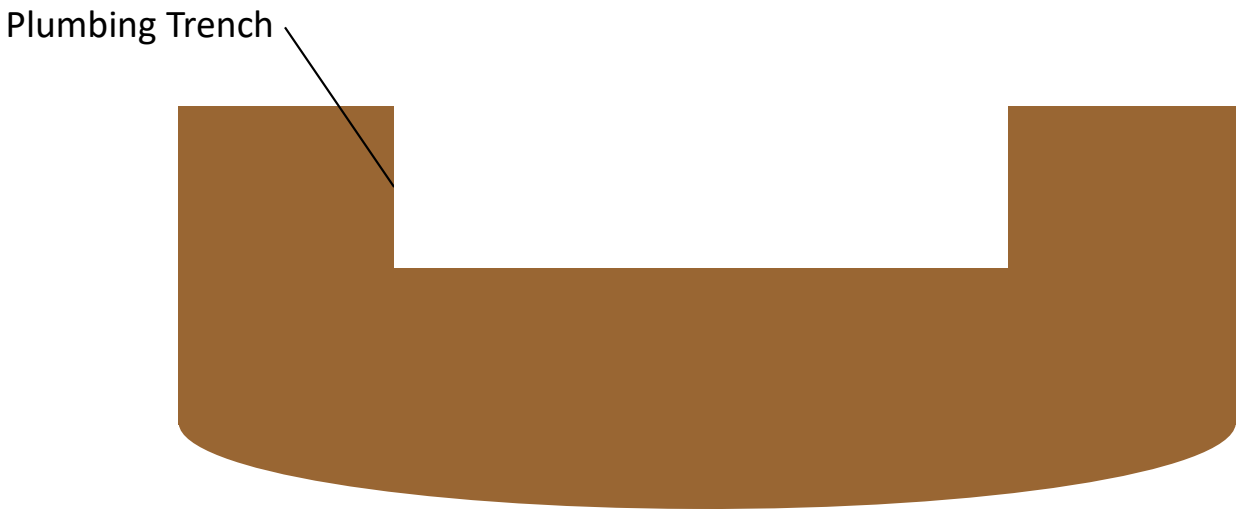
Pre-Installed



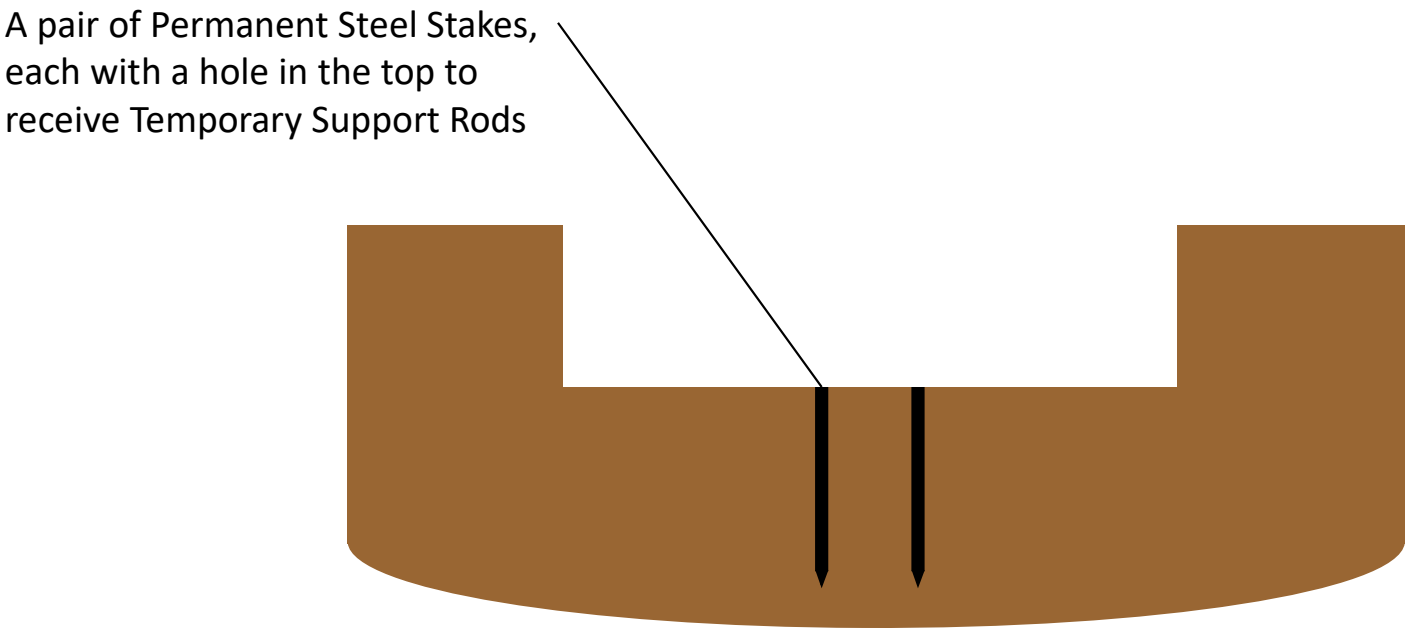
Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork



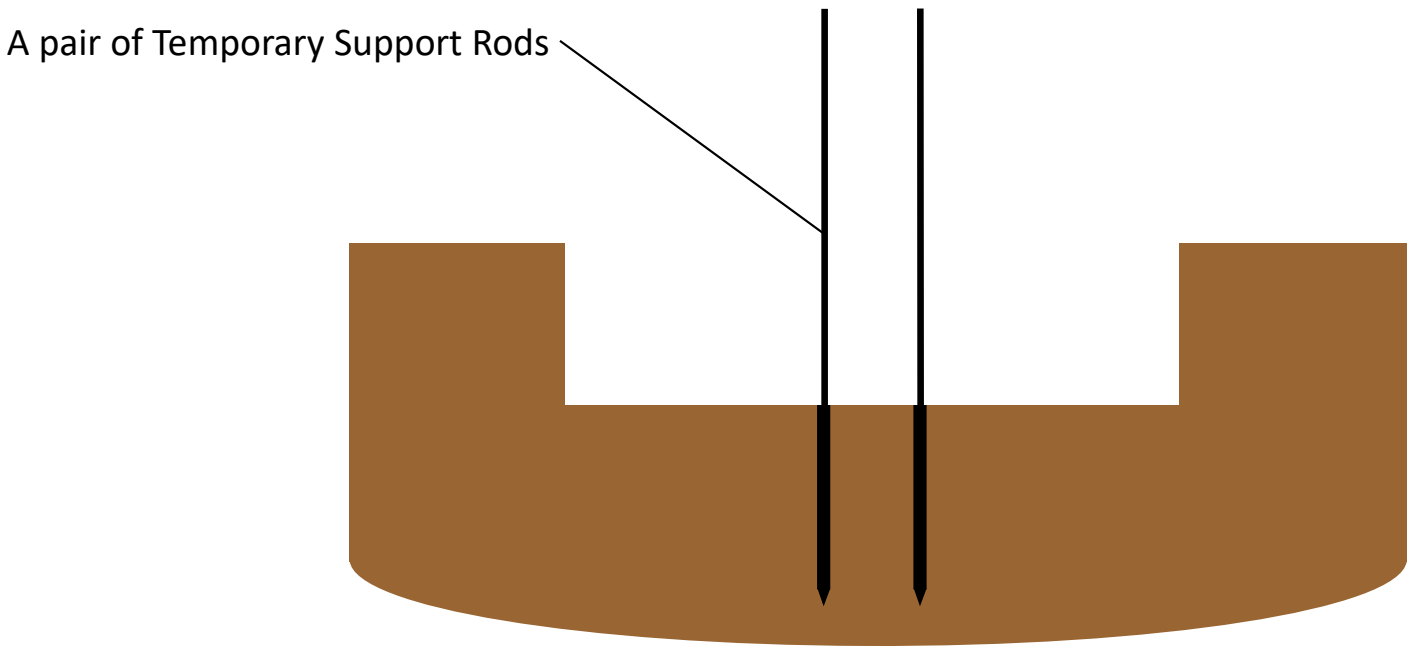
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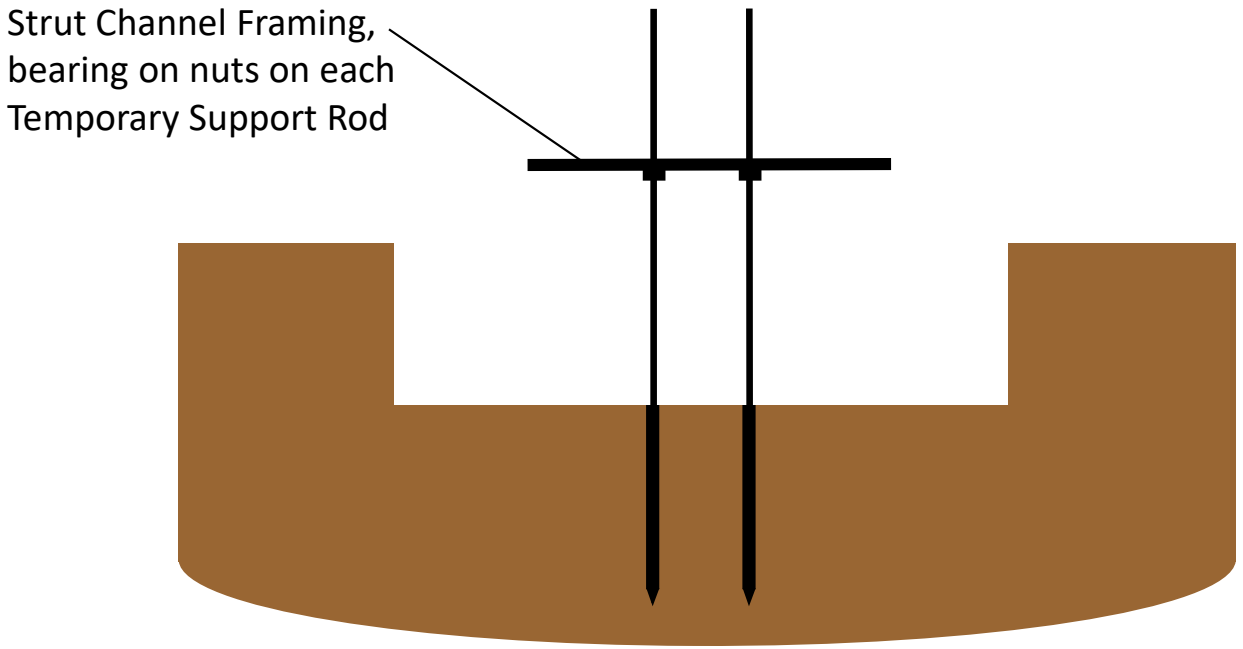
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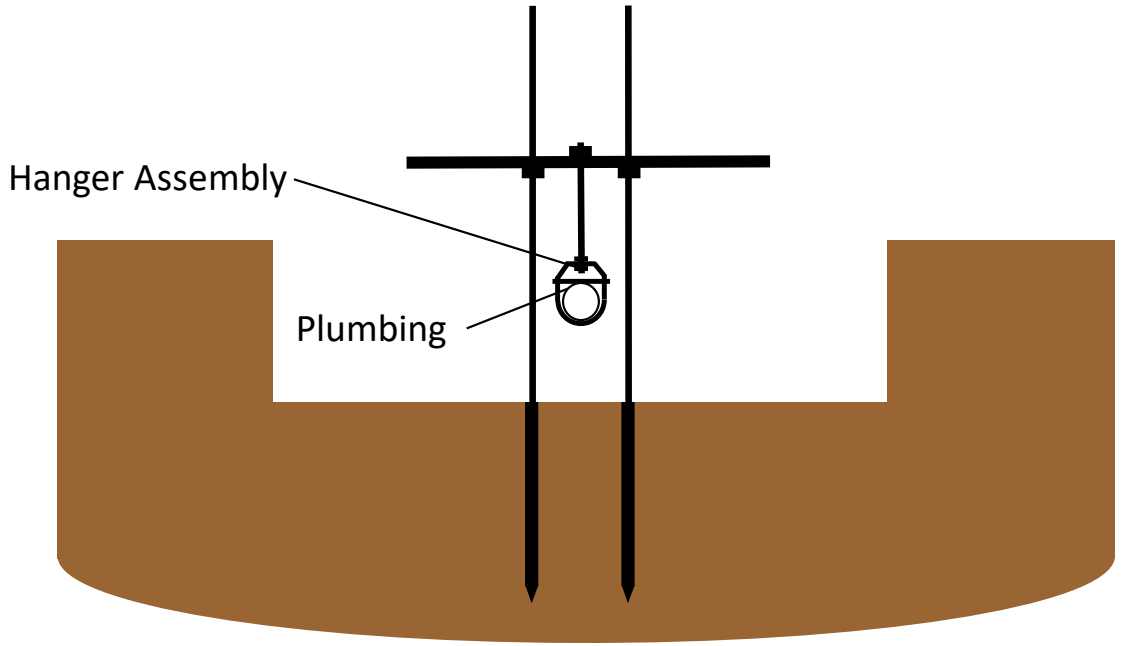
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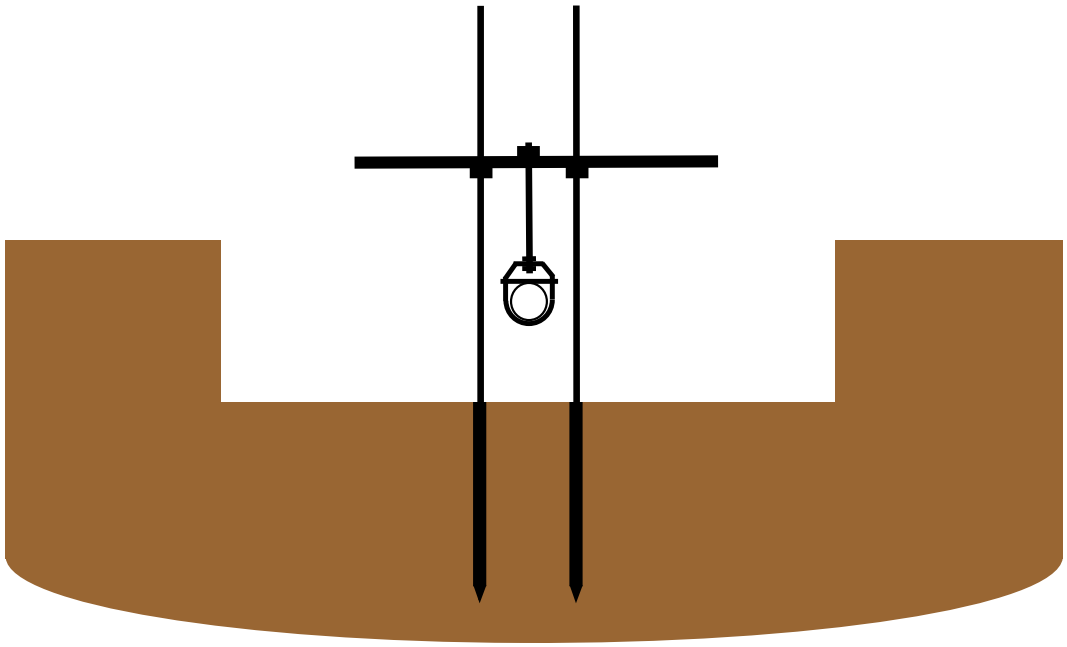
Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork



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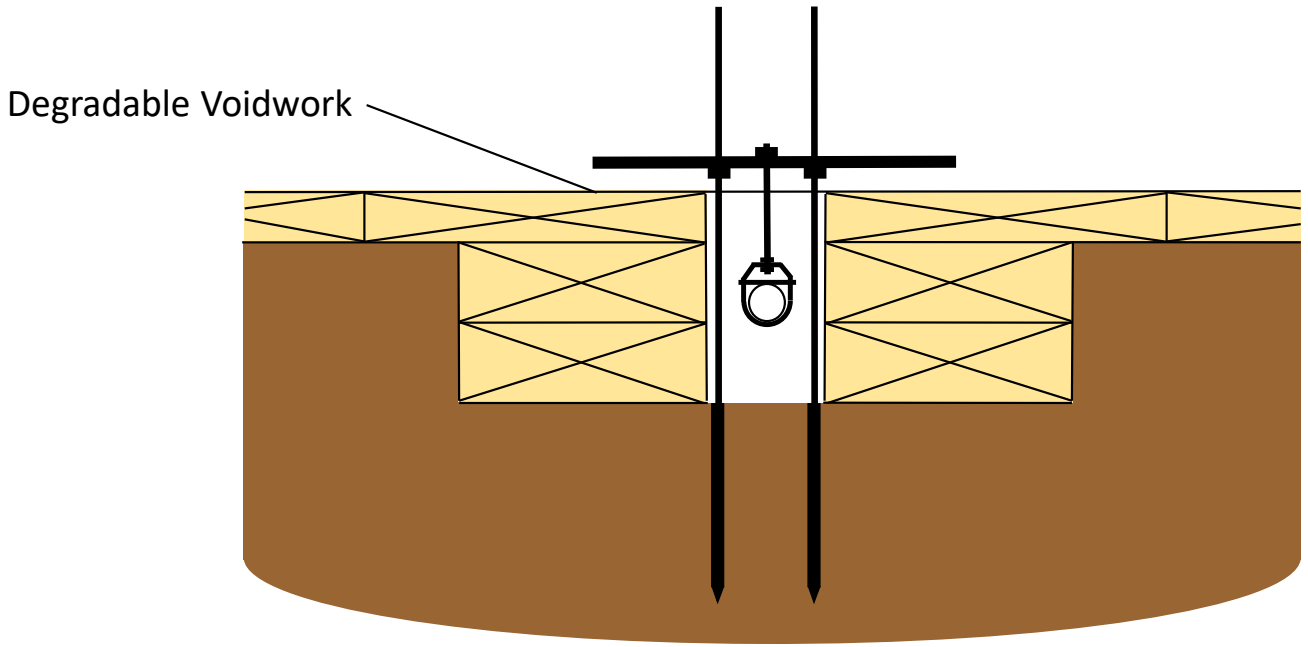


Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork

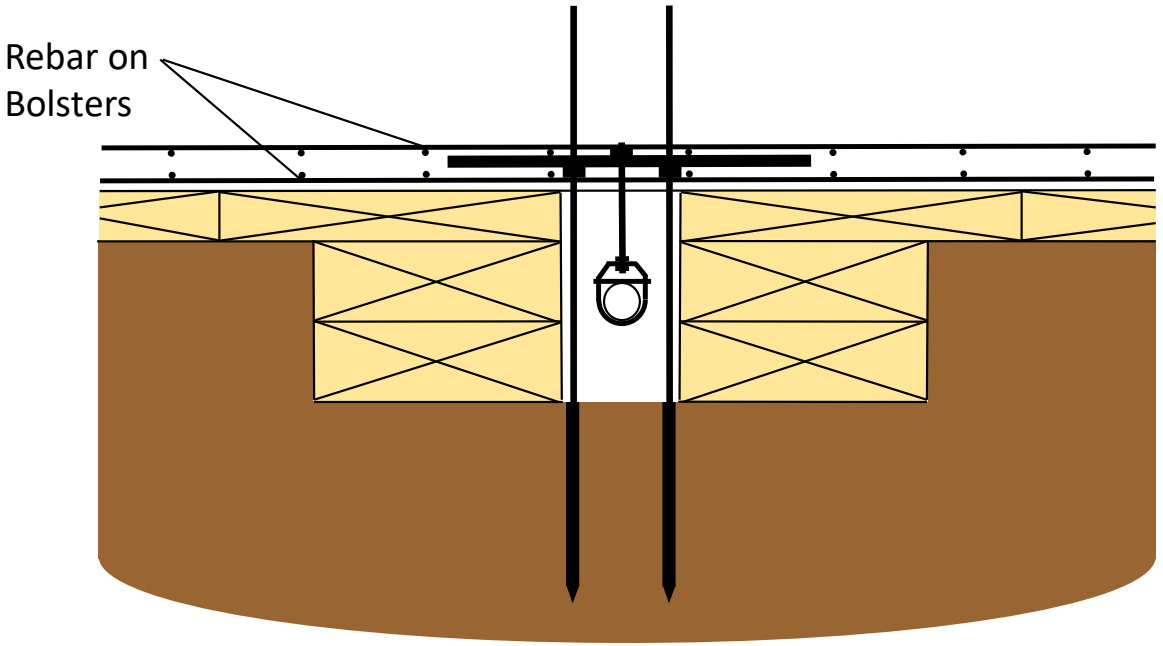


Initial Temporary Support System

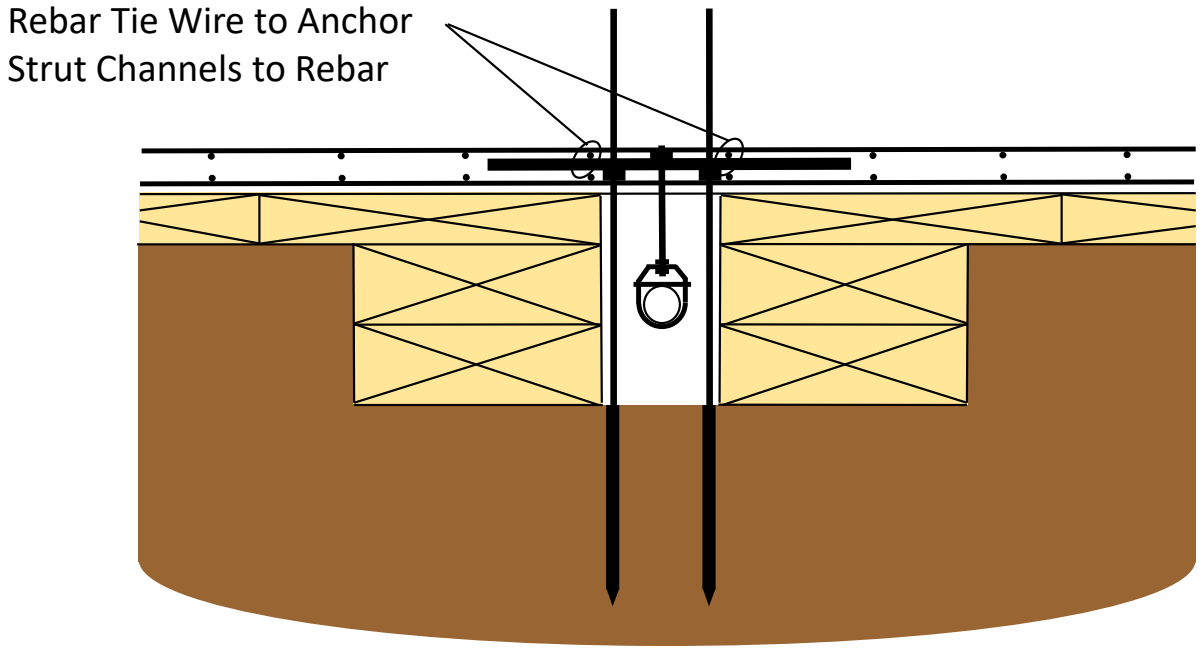
Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork



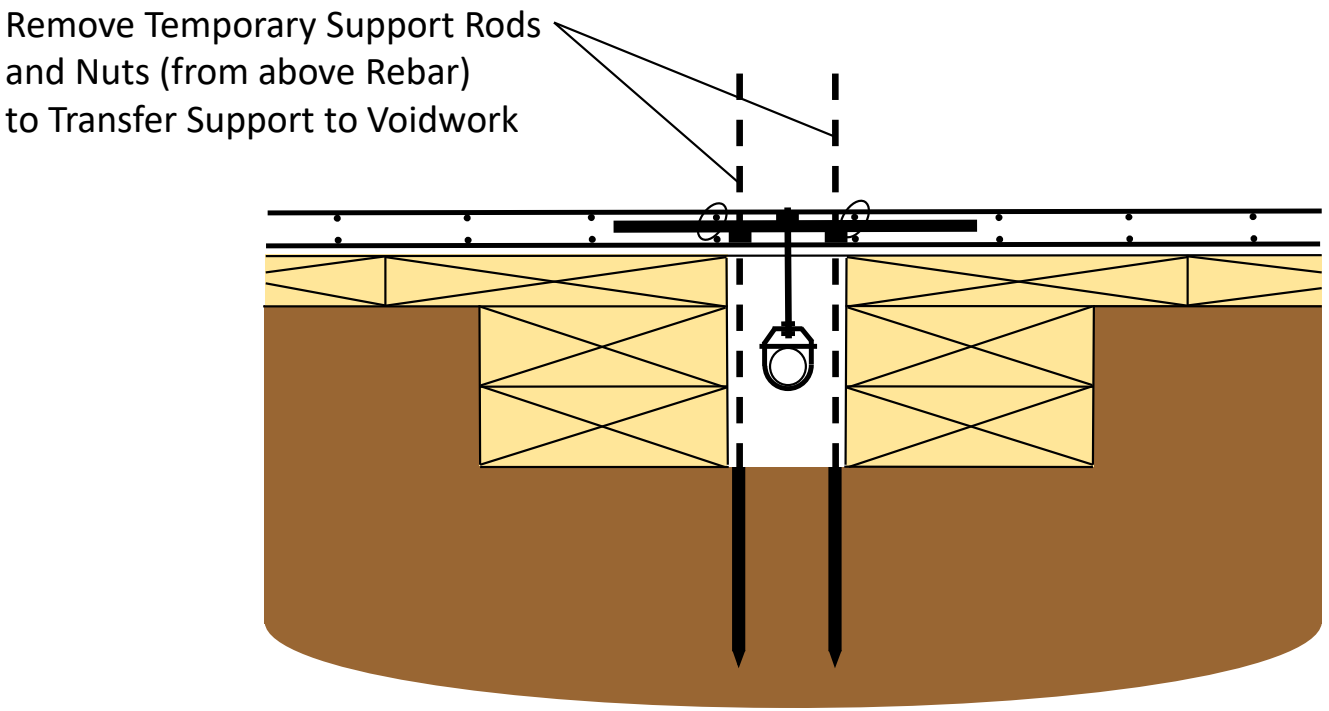
Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork



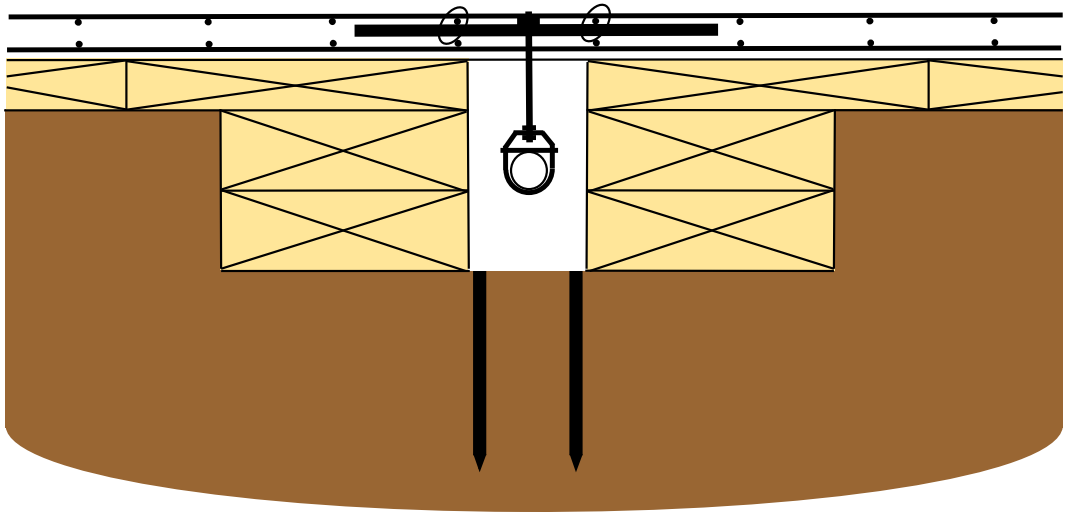
Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork



Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork

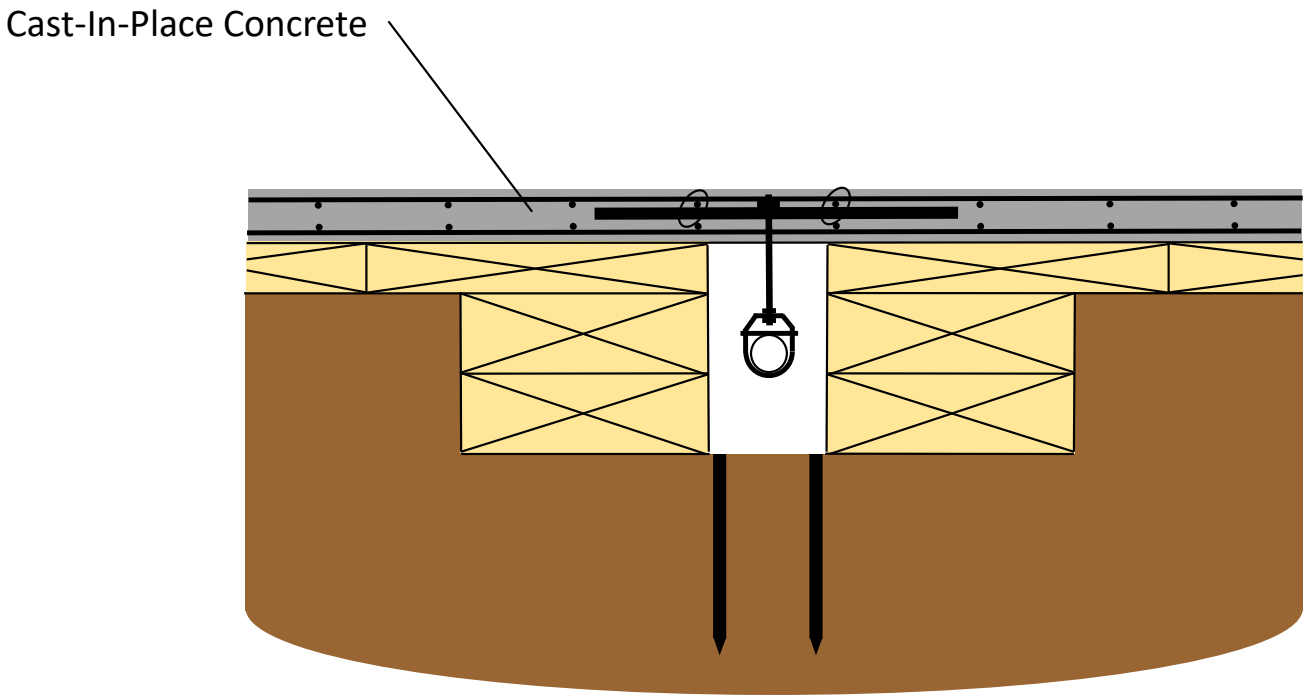


Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork

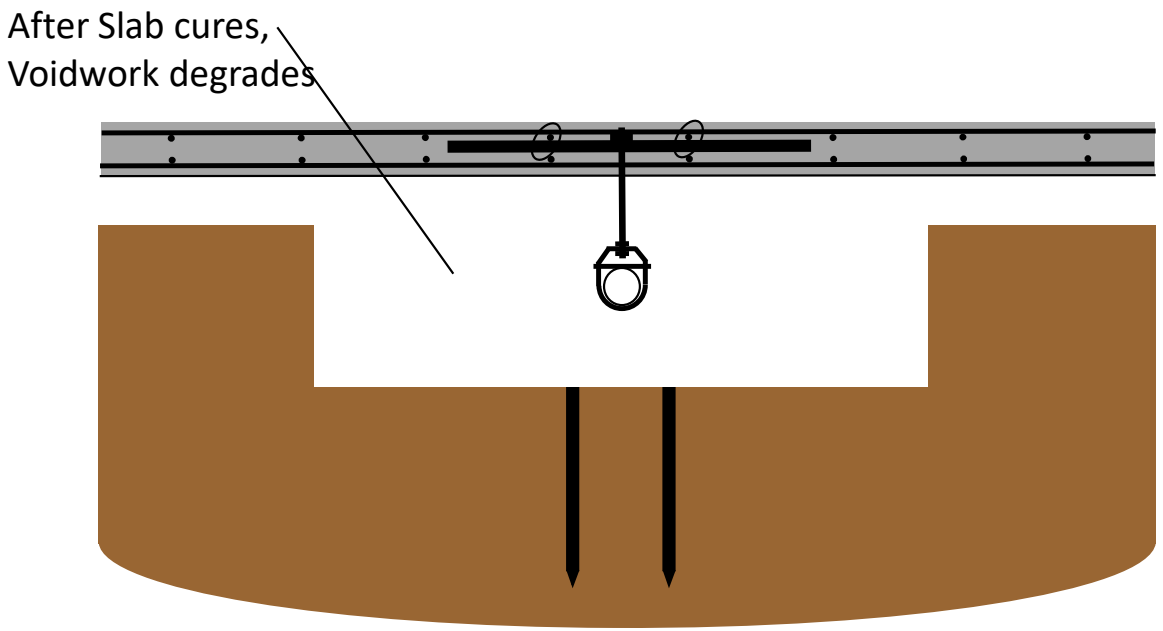


Secondary Temporary Support System

Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork



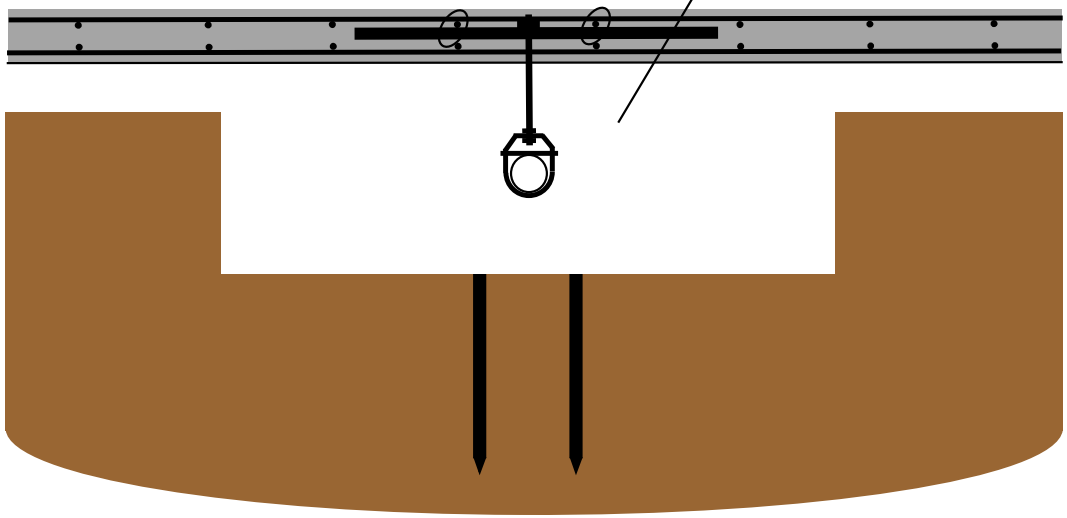
Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork



Example of Pre-Installed Isolated Plumbing Under Slab-on-Voidwork

This complies with all editions of the IPC and all editions of the UPC, whereas non-isolated void systems do not.

This condition is “isolated plumbing” because the plumbing, hangers and supports below the slab are not in contact with the subgrade or in contact with any assemblage of materials that is in contact with the subgrade.



Permanent Support System



Additional Benefits of this Pre-Installed Isolated Plumbing Example

+ Plumbing can be easily inspected and adjusted before a slab pour (which is not true with non-isolated void systems around plumbing)

+ Plumbing can be easily inspected, repaired and replaced over time (which is not true with non-isolated void systems around plumbing) once utility trenches are accessed through an exterior gradebeam.

Economical Design of Isolated Plumbing Under Isolated Slabs

+ Cluster under-slab plumbing, having multiple points of connection to site utiltities, so as to reduce the depth of excavation and reduce the total linear feet of plumbing under the building. While this may increase the total linear feet of utilities outside of the building, plumbing outside of the building will not be fighting the resistance of the isolated slab and it is often much more economical to repair utilities outside of the building if routine maintenance is required.

+ As part of the foundation system on deep foundation elements, provide vaults, outside of the building, to house plumbing flexible expansion joints to coordinate the connection between site utilities and under-slab utilities without interfering with the pour schedule for the building and while allowing routine inspection and maintenance of flexible expansion joints as the soil-supported end rises and falls with the soil elevation.

+ Provide an initial offset in the plumbing flexible expansion joint that is the sum of the offset necessary for minimum code slope and the offset necessary to overcome the potential vertical movement for the soil at that depth. Where possible, provide pvc flexible expansion joints instead of epoxy-coated cast iron, lowering the elevation of the plumbing flexible expansion joint to reduce the pvm expected so that pvc flexible expansion joints can be used. Coordinate the elevations with structural and civil engineers.

+ Discuss preliminary layouts of plumbing with a pre-installed isolation system detailer for discussion of the most economical layout before 100% Design Development, so that the other engineering disciplines can accommodate for their design responsibilities and cost estimators can account for all expected costs early.

How to Specify Isolated Plumbing under Isolated Slabs

Where Isolated Slabs are designed by Structural Engineers:

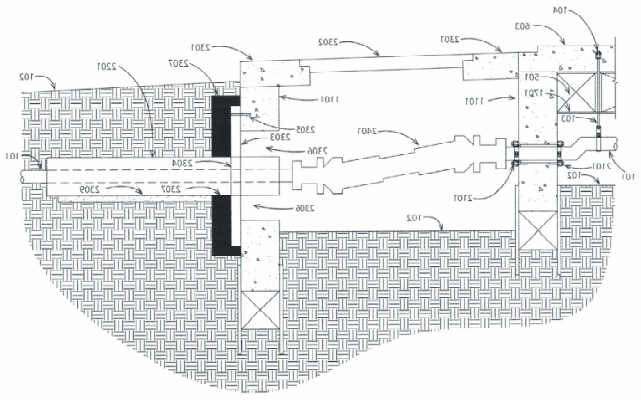
+ Require the plumbing, hangers and supports below the slab not be in contact with the subgrade and not be in contact with any assemblage of materials that is in contact with the subgrade, specifically prohibiting buried plumbing and non-isolated void systems (e.g. specifically identifying any common non-isolated void products that are prohibited, to avoid confusion during bidding). Regardless of the applicable building code, plumbing designers can specify protection of plumbing comply with 2024 IPC Section 305.8.2 as a project requirement, because this language was added to make enforcement of basic protection provisions (such as IPC Section 305.2 in all editions) easier for plumbing inspectors.

+ Permit both post-installed isolated plumbing (e.g. any of the various, non-proprietary methods of installing plumbing in an underfloor space such as under a slab-on-crawlspace even under a slab-on-voidwork) and pre-installed isolated plumbing (explicitly prohibiting the contractor infringe on any intellectual property rights related to any construction methods used). Allow the Contractor to determine which method (post-installed vs. pre-installed) is most cost-effective given the project schedule. This specification approach is not limited to a sole-source supplier and should therefore suitable on both public and private projects.

How to Specify Isolated Plumbing Transitions beyond Isolated Slabs

At the perimeter of Isolated Slabs designed by Structural Engineers:

+ To connect to site utilities, specify a “horizontal” flexible expansion joint with an initial vertical offset between the ends that is sufficient to allow upward PVM of the soil-supported site utiliites and still have sufficient slope to drain over the length of the flexible expansion joint as required by the applicable plumbing code for new plumbing, with the flexible expansion joint installed in a structurally engineered vault that is part of the foundation system but outside of the slab perimeter, with a pipe clamp mounted to the foundation at the slab perimeter and a reinforcing pipe collar where the utilities penetrate a sliding soil retainer that allows the plumbing to slide up and down a vertically slotted hole in the vault. Explicitly prohibit the contractor from infringing on any intellectual property rights related to any construction methods used so as to avoid a claim by an inventor that you were inducing the Contractor to infringe.



Recommendation to Plumbing Designers

1. If you suspect that expansive soil is present because of local history, ask the Registered Design Professional in Responsible Charge or “RDPiRC” (e.g. Architect) which foundation areas, if any, are likely to have isolated slabs. Preliminary layouts of plumbing should provide economical isolated plumbing under those areas.
2. Ask the RDPiRC if a Geotechnical Investigation has been or will be performed for the project. If so, obtain a copy and read the report to determine if expansive soil is present, before a set of construction documents is issued. If additional information is needed, such as recommended Design Vertical Movement or maximum vertical to horizontal ratio for subgrade cut clearances, request the information.
3. Ask the Structural Engineer to identify in plan view any and all foundation areas which will have isolated slabs, before a set of construction documents is issued.
4. Under isolated slabs, specify isolated plumbing and provide flow line elevations at critical locations for bidding coordination between trades (e.g. earthwork under the building, voidwork, plumbing, site utilities and concrete subcontractors). At the perimeter of isolated slabs, specify isolated plumbing transitions. Under non-isolated slabs, specify buried plumbing with utility trench backfill in accordance with Geotechnical Engineering recommendations. Coordinate specifications and details with the Architect, Structural Engineer, Civil Engineer and Geotechnical Engineer.