WICK DRAIN GUIDE SPECIFICATION (METHOD)

DEEP FOUNDATIONS INSTITUTE

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Prepared by the
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Deep Foundations Institute
326 Lafayette Avenue
Hawthorne, New Jersey 07506 USA
www.dfi.org

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PREFACE AND ACKNOWLEDGEMENTS

Wick drains, also known as prefabricated vertical drains, PVDs, PV Drains, and band drains, are light-weight, flexible geocomposite drains that are inserted into the ground primarily for purposes of enhancing or altering drainage in subsurface layers. Wick drains consist of a central core that is wrapped inside of filter fabric. The most common use of wick drains is to accelerate consolidation in fine-grained, slow-draining layers. Other applications for wick drains, such as collecting contaminated groundwater are less common.

At many sites, wick drains are installed prior to the placement of a pre-load/surcharge, with the pre-load exerting similar or greater stresses than the proposed structure. For earthen structures such as embankments, levees, dams, and mechanically stabilized earth (MSE) walls, wick drains are used to accelerate the increase in strength of the underlying consolidating soils by dissipation of excess pore pressure so that waiting times between lifts of fill can be reduced, and the majority of the settlement of the soft foundation soils occurs prior to the feature being put in service. The acceleration of the increase in strength of the underlying soils is accomplished by dissipation of excess pore water pressure and decrease of void ratio.

For structures to be built over weak or compressible soils, wick drains can be used in conjunction with a pre-load or surcharge to accelerate both the increase in strength, and the consolidation settlement of the soil. The surcharge, which is removed before the structure is built, is designed to exert similar or greater stresses than the proposed structure.

Wick drains serve to reduce the travel time for water flowing out of the consolidating layer. Consolidation theory assumes that the layer is laterally continuous and water must escape from the layer by flowing into an overlying or underlying permeable layer. With wick drains, water flowing horizontally will be intercepted by a drain and there is enough excess pore water pressure to rapidly push the water into and through the drain. Drainage is enhanced not only by reducing the drainage distance, but also by virtue of the fact that horizontal drainage velocities may be several times greater than those in the vertical direction due to the presence of thin silty or sandy layers and horizontal bedding planes.

Today, most wick drains are comprised of a channeled or studded polymeric core encased in non-woven geotextile fabric. The drains are approximately 4-inches (100 mm) wide by 1/8 inch (3 mm) thick. Water flows through the porous fabric and is conveyed vertically until a porous layer is encountered.

Installation

Following the initial set up and feeding of the wick drain material through the mandrel, wick drains are installed by pushing a hollow, steel mandrel, typically rectangular or rhombic in section, into the ground. The mandrel houses the wick material and protects it from damage as the mandrel is inserted into the ground to the termination depth. At the base of the mandrel, the wick material is looped through or around an anchor that is designed to hold the drain securely in place as the mandrel is extracted. Once the mandrel has been extracted from the ground, the wick drain is cut and the next drain is installed.

Wick drain installation units are typically powered and supported by crawler excavators or by cranes, depending on the depth of the drain and weight of the installation unit. Pull down is typically accomplished by heavy chain, cable, or gear systems. Depending on the subsurface conditions, the mandrel may be vibrated or statically pushed into the ground.

Site Considerations

Because wick drains are commonly installed at sites where soft soils are present near the ground surface, and the equipment is very tall and heavy, it is necessary to provide a stable working surface. In most cases, the installation of a 12- to 24-inch (300- to 600-mm) thick sand or stone platform will provide sufficient traction and support for the wick drain installation equipment. Where the ground is especially soft, geotextiles or geogrids are installed prior to the placement of the granular platform.

It is typically necessary to provide a drainage layer that is of adequate thickness and gradation to receive the flow of water conveyed up through the wick drains. Ideally, the granular working platform can be designed to double as the drainage blanket. Horizontal strip drains may be used in lieu of the sand blanket if the existing ground can provide a well-draining, stable working surface that will not rut or turn to mud.

For safety reasons, the site should be as flat as reasonable, with minimal pitch to affect positive drainage. With special precautions, it may however be possible to install wick drains on gentle slopes. The designer should consider topographic features such as hills and slopes, and also be cognizant of the presence of overhead power lines and buried utilities when designing a wick drain program. With special modifications to the equipment, drains can be installed in limited headroom settings, or at an inclination to help overcome site constraints. Where hard layers are present, punching, drilling or augering can be used to loosen the ground to allow for wick drain installation.

Specifications

The provided method specification is intended as a guide. The Engineer should review it carefully and make the necessary adjustments to account for the size, complexity, conditions and specific requirements of the project.

Martin G. Taube, P.E., P.G.
Ground Improvement Committee Chair

Matthew Barendse, P.E.
Ground Improvement Committee Member

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1.0 DESCRIPTION

This work consists of furnishing all necessary labor, equipment, and materials to install prefabricated vertical (wick) drains in the ground in accordance with the Plans and as specified herein.

2.0 REFERENCED CODES AND STANDARDS

ASTM D4716-08	Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D4632-08	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4533-11	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4491-99a	Standard Test Methods for Water Permeability of Geotextiles by Permittivity (2009)
ASTM D4751-04	Standard Test Method for Determining Apparent Opening Size (A.O.S.) of a Geotextile
ASTM 6918-09	Standard Test Method for Testing Vertical Strip Drains in the Crimped Condition

3.0 QUALIFICATIONS

The Contractor shall have successfully completed a minimum of five wick drain installation projects in similar ground conditions, and installed not less than 5,000,000 linear feet (1,525,000 linear m) of wick drain in the past five years. The Contractor shall have a minimum of five continuous years of wick drain installation experience.

C3.0 A list of pre-qualified wick drain subcontractors may be included to expedite the bidding process. Consult the DFI Membership Directory. The experience requirements may be reduced at the Engineer's discretion.

4.0 SUBMITTALS

At least 30 days prior to the commencement of work the Contractor shall submit the following for review and approval:

4.1 Experience. A list of a minimum of five (5) completed wick drain projects identified by name, location, project description, size, completion date, description of soil conditions, and contact person for the contracting organization.

4.2 Manufacturer's wick drain material specifications identifying compliance with the requirements of Section 5.0 *Materials*.

4.3 A 5-foot (1.5-m) long sample of the wick drain that will be installed. The sample shall be stamped or labeled by the manufacturer as being representative of the wick drain having the specified trade name.

4.4 Size, type, weight, maximum pushing force, vibratory energy (if applicable), and configuration of the installation rig in accordance with the requirements of Section 6.0 *Equipment*.

4.5 Dimensions and length of mandrel in accordance with the requirements of Section 6.0 *Equipment*.

4.6 Details of wick drain anchorage.

4.7 Detailed description of proposed installation methods, including methods for overcoming obstructions and methods for splicing wick drains.

5.0 MATERIALS

The prefabricated drains are composed of a corrugated polymeric drainage core and a non-woven geotextile. The drains may be either non-bonded or bonded. For non-bonded drains, the geotextile is wrapped around the corrugated core and seamed to itself. For bonded drains, geotextile is fused to both faces of the core along the peaks of the corrugations.

The assembled drains shall have the following minimum properties:

Total Discharge Capacity (@ 40 psi (275 kPa) and unit gradient)	1.5 gpm (5.7 lpm)	ASTM D4716

The non-woven geotextile shall have the following minimum properties:

Grab Tensile Strength*	130 lbs (578 N)	ASTM D4632
Trapezoidal Tear**	60 lbs (267 N)	ASTM D4533
Permittivity	0.7 sec^{-1}	ASTM D4491
A.O.S.	70 sieve	ASTM D4751

The core shall have the following minimum properties:

Grab Tensile Strength*	200 lbs (890 N)	ASTM D4632

*For bonded drains, grab tensile strength tests may be

C5.0 The minimum material requirements given in this specification are adequate for typical conditions where wick drains are used. However, it is the responsibility of the Engineer to verify that all material properties are appropriate for their specific site. (For instance, contaminated sites may require additional standards.) The Engineer may opt to add a clause which allows the use of specific pre-approved products or a clause which requires that a minimum quantity of the product has been successfully used on recent projects (e.g. 5,000,000 linear feet (1,525,000 linear m) in the past five years).

The Engineer may add minimum values for discharge capacity under crimped conditions if severe deformations are anticipated. The test method should be ASTM 6918-09 "Standard Test Method for Testing Vertical Strip Drains in the Crimped Condition."

conducted on the assembled drain using ASTM 4595.
**For bonded drains the trapezoidal tear test should be waived.

5.1 Handling and storage of wick drain materials should follow the manufacturer's recommendations. During shipment and storage, the wick drain material shall be wrapped in a heavy-duty protective covering. The storage area shall be such that the wick drain material is protected from sunlight, mud, dirt, dust, debris, and detrimental substances. The drains shall be free of defects, rips, holes, or flaws. Damaged materials shall be replaced at the Contractor's expense.

5.2 All wick drain material delivered to the site shall be labeled or tagged for quality control purposes. Each roll shall be identified by lot or control numbers, individual roll number, date of manufacture, manufacturer, and product identification.

5.3 Wick drains shall be produced by a manufacturer with an in place quality control program which is monitored by an independent third party testing organization.

C5.3 The Engineer may elect to require project-specific laboratory testing to verify that the minimum property requirements are met. The testing frequency should be specified with consideration given to project size. A typical test frequency is one test per 500,000 linear feet (152,500 linear m).

6.0 EQUIPMENT

6.1 The wick drains shall be installed with equipment which will causes a minimum of disturbance to the subsoil during the installation. The wick drains shall be installed with a sleeve or mandrel that will be advanced to the required depth using constant load, or constant rate of advancement methods. The mandrel shall protect the wick drain material from tears, cuts and abrasions during installation and shall be withdrawn after the installation of the drain. The drain shall be installed with the approved anchorage to anchor the bottom of the drain at the required depth at the time of mandrel removal. The cross sectional area of the mandrel and anchor combination shall not be greater than ten (10) square inches (6450 square mm). The wick drain installation unit shall be capable of applying a minimum downward force of 30,000 lbs (133 kN).

6.2 The use of falling weight impact hammers or jetting shall not be permitted for installation of the wick drains. Vibratory techniques may be used to penetrate stiff upper soil layers but may not be used once the mandrel has penetrated underlying compressible soils.

C6.2 Vibration may reduce permeability or increase remolding in certain soil types.

7.0 CONSTRUCTION

C7.0 Preparation of the working area will greatly affect wick drain

7.1 Mark the proposed locations of the wick drains and take all reasonable precautions to preserve the markers. Verify the location of all existing utilities and instrumentation devices prior to installing the wick drains.

7.2 Wick drains that deviate from the plan location by more than 6 inches (150 mm), or are damaged, or are improperly installed, will be rejected and no compensation will be allowed for any materials furnished or for any work performed on such wick drains. Replacement wick drains shall be offset from the location of the rejected wick drains as directed by the Engineer. The rejected wick drains shall remain in place.

7.3 Install the wick drains vertically to the depth(s), elevation(s), described levels, or to the firm substratum indicated in the Plans. Firm substratum is defined as the layer which resists further penetration at a reasonable effort. The Contractor shall provide the Engineer with a suitable means of verifying the plumbness of the mandrel and determining the tip elevation of the wick drain at any time. The equipment shall be carefully checked for plumbness and shall not deviate more than 0.25 inch per foot (20 mm per meter) from the vertical. The wick drains shall be installed in such a sequence that construction equipment will not damage previously placed wick drains.

7.4 Splicing of the drain material shall be conducted in accordance with the manufacturer's recommendation to ensure structural integrity and hydraulic continuity of the drain. A maximum of one splice per drain will be permitted without specific permission from the Engineer.

7.5 Where obstructions or hard layers are present that prevent the installation of a wick drain, the Contractor will make two additional attempts to install a wick drain within 18 inches (450 mm) of the original location. If the drain can still not be installed, the location will be marked and designated for obstruction clearance by means of augering, drilling, punching, or spudding. Obstruction clearance in accordance with the approved procedure will be permitted to a maximum depth shown on the Plans, or as directed by the Engineer, and only where prior approval is given by the Engineer.

installation rates. Separate specifications should be used for preparing the ground surface and installing the working/drainage pad. Typically, the surface is smoothed and leveled to be as flat as reasonably possible. In most cases the drainage blanket is installed before the drains to function as a working pad and to protect the underlying soils from damage, however, possible contamination from drill/auger spoils should be considered.

C7.3 In cases where the compressible layer is very thick and the drains will not reach the bottom, wick drain lengths may be specified by depth (or elevation). Otherwise, illustrating the approximate top of the firm substratum in the plans is usually preferable. In any case, the Engineer should clearly convey the expected lengths of the wick drains in the plans and specifications and provide the contractor with all available subsurface information.

C7.5 The Engineer may require that pre-loosened holes be backfilled. If required, sand is typically used as the backfill material. Contractor should be allowed to push or dump the sand into the drill hole, either before or after the wick drains are installed.

7.6 Where obstructions cannot be cleared by the methods listed in Section 7.5, the Engineer will determine if the wick drain is to be abandoned or installed to the required tip elevation.

7.7 Cut wick drains neatly at the upper end with a 4 to 8 inch (100 to 200 mm) length protruding above the working surface, or as shown on the Plans.

C7.7 The cutoff length may be increased to leave excess wick drain to connect to horizontal strip drain.

8.0 METHOD OF MEASUREMENT

8.1 Mobilization will be paid for by lump sum.

8.2 Wick drains will be measured and paid for as the number of linear feet satisfactorily installed, or abandoned as directed by the Engineer, from the tip elevation to the level of the working surface, plus the allowable length of wick drain protruding above the working surface.

C8.2 On large projects in particular, the Engineer should be allowed to opt to use roll count to track the quantity of wick drain installed. However, this should not relieve the Engineer from observing installations and verifying that design depths are achieved.

8.3 Obstruction clearance will be measured and paid for as the number of linear feet from the working surface to the depth penetrated by the auger, spud, drill, or punch.

C8.3 If significant obstructions are anticipated, an estimated quantity of obstruction clearance should be included in the contract documents. If obstructions are not anticipated obstruction clearance work should be paid for by force account.

9.0 BASIS OF PAYMENT

9.1 Mobilization shall include the cost of furnishing of all equipment and materials necessary to properly execute the work.

9.2 The unit bid price for wick drains shall include the cost of survey and stakeout, installing wick drains, and furnishing all labor, tools, and incidentals necessary to complete the work.

C9.2 On projects where shallow drain lengths (less than 30 feet (9 m) deep) are anticipated, a per each, or a per each and per foot payment unit is recommended.

9.3 The unit bid price for obstruction clearance shall include the cost of satisfactorily clearing obstructions to facilitate the installation of the wick drains, disposal of spoils, any required backfilling and furnishing all labor, tools, and incidentals necessary to complete the work.