



## SECTION 605

### UNDERDRAINAGE

**605.1 Description.** This work shall consist of furnishing and installing underdrains and edge drains as shown on the plans or as directed by the engineer, and shall include excavating the trench, installing all required drainage media, and backfilling with material as specified or as directed by the engineer.

**605.2 Material.** All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Aggregate for Drainage	1009
Geotextile	1011
Geocomposite Edge Drain	1012
Outlet Pipes	1013
Pipe Aggregate Pavement Edge Drain	1013
Corrugated Metallic-Coated Steel Cross Drain and Structural Drain Pipe	1022
Corrugated Aluminum Alloy Cross Drain and Structural Drain Pipe	1025

**605.2.1** All underdrain and edge drain pipes shall be perforated, except as specified otherwise.

**605.2.2** All special fittings, such as caps, wyes, tees and couplings, shall be of standard design and manufacture, and shall be compatible with the type of pipe or geocomposite drain to be used.

**605.2.3** All steel fittings shall be zinc or aluminum coated.

**605.2.4** All welds and cuts of steel pipe or fittings shall be repaired after welding, in accordance with [Sec 1020](#).

#### **605.3 Construction Requirements.**

**605.3.1** Although probable locations of underdrains are shown on the plans, modifications may be necessary due to conditions found on the project. The contractor shall perform work only as shown on the plans or as specified or approved in writing by the engineer.

**605.3.2** Any underdrain trenching that results in an uneven trench bottom or exposes soft, yielding or unstable ground in the trench bottom shall be undergraded and backfilled with drainage aggregate material of sufficient thickness to ensure maintenance of proper alignment and gradient for all subsequent operations.

**605.3.3** Any required drain pipe shall be firmly bedded and carefully aligned. The pipe shall be laid with perforations down if the perforations are not uniformly distributed around the circumference of the pipe, unless otherwise shown on the plans. All longitudinal pipe shall slope toward an outlet pipe at a minimum rate of one inch (25 mm) per 10 feet (3 m). Sections shall be jointed with approved fittings. Dead ends of pipe shall be completely closed by

means of caps or plugs. Outlet openings shall be a minimum of 6 inches (150 mm) above the ditch bottom, and shall be protected with rodent screens in accordance with [Sec 1013](#). Outlet pipe openings that are not exposed shall be connected to drain as shown on the plans or directed by the engineer.

**605.3.4** Geotextile shall be used to completely envelope any drainage aggregate in trenches, except a geotextile will not be required when Grade 1 drainage aggregate is used, and only partial envelopment may be required when the underdrain abuts or is overlain by an approved open-graded base course or other drainage medium. A drainage geotextile wrap or sock shall envelope perforated drainage pipe when Grade 1 or Grade 2 drainage aggregate is used, or whenever any portion of a perforated pipe used as a discharge pipe is backfilled with soil.

**605.3.5** Porous backfill shall be ponded with water immediately before covering to effect maximum settlement of backfill.

## **SECTION 605.10 PIPE-AGGREGATE PAVEMENT EDGE DRAIN.**

**605.10.1 Description.** This work shall consist of placing a continuous pipe-aggregate edge drain under the edge of new pavement as shown on the plans or as directed by the engineer.

**605.10.2 Construction Requirements.** Aggregate shall be Grade 3, except [Sec 1005.2](#), Gradation A material, Grade 4 or Grade 5 drainage aggregate. Edge drain pipe shall have a nominal internal diameter of 4 inches (100 mm) unless otherwise shown on the plans.

**605.10.2.1** The contractor shall select plastic pipe meeting these specifications, except that geocomposite drains shall not be used. Pavement edge drains shall be provided with outlet pipe and splash pads in accordance with [Sec 605.60](#).

**605.10.2.2** Trenching, placement, and backfill of underdrains shall be performed only after Type 1 or Type 5 base is placed and compacted. Backfill material shall be compacted by three passes of a vibrating pad or drum-type compactor approved by the engineer.

**605.10.2.3** If a pipe-aggregate pavement edge drain is used on a pavement rehabilitation project, the contractor shall not install the drain until all pavement repair and required undersealing have been completed in the area where the edge drain is to be placed.

**605.10.2.4** Under new pavement, pipe-aggregate pavement edge drains shall be lined with geotextile and wrapped. Edge drains underneath stabilized permeable base shall have the geotextile wrapped around the outside edge and over the top of the permeable base. The trench for pipe-aggregate pavement edge drains shall be lined and wrapped with a geotextile as shown on the plans.

**605.10.2.5** All longitudinal edge drains and outlet pipes installed on the project will be subject to video camera inspection as directed by the engineer.

**605.10.2.5.1** Video inspection shall be conducted after all paving is complete. The engineer may randomly select no less than ten percent of the lateral outlet pipes for inspection and extend inspection to 500 feet (150 m) of the mainline pipe. Inspection areas shall not overlap each other, if possible. If deficiencies are found, a more extensive video inspection with expanded video coverage shall be conducted, which may inspect any or all of the edge drains on the project, as directed by the engineer.

**605.10.2.5.2** The video camera head shall remain centered in the pipe during the inspection. The camera shall be capable of negotiating a 90° angle from the 4-inch (100 mm) outlet pipe to the 4-inch (100 mm) longitudinal pipe. Camera progress shall be clearly visible on an

8-inch (200 mm) or greater monitor screen. The unit shall be able to record and play back the inspection. The unit shall allow audio dubbing during the inspection. The contractor shall provide a copy of the video inspection tapes to the engineer within three working days of inspection.

**605.10.2.5.3** If the inspection reveals crushed or compressed pipe, separated joints, obstructions within the pipe that prohibit the passage of the camera head, rips or cracks in the pipe wall, or longitudinal sags which allow silt to collect or water to stand in more than half the pipe depth, repair or replacement of the deficient portions of outlet or longitudinal pipe and the repair of the pavement, which is damaged by improper installation of the drain or the repair of deficient portions of the drain, shall be performed at the contractor's expense.

**605.10.3 Method of Measurement.** Measurement of pipe-aggregate edge drain will be made to the nearest linear foot (0.5 m) along the centerline of the drain, center to center of fittings and junctions.

**605.10.4 Basis of Payment.**

**605.10.4.1** Accepted quantities of pipe-aggregate edge drain will be paid for at the contract unit price per linear foot (m), or at an adjusted contract unit price per linear foot (m) as described herein. No overrun or underrun of contract quantity will constitute the basis for contract adjustment, other than as provided in [Sec 605.10.4.2](#). No direct payment will be made for excavating the trench, backfilling and backfill material, or for video inspection of the outlet and longitudinal pipes. Outlet pipes will not be separately paid for, except in combination with any required splash pad.

**605.10.4.2** Adjustments in the contract unit price per linear foot (m) of pipe-aggregate edge drain will be made in accordance with the following schedule where the engineer directs an increased depth of excavation from that shown on the plans. For purposes of determining the adjusted price, the excess depth of excavation will be averaged for the entire length of the drain if less than 100 feet (30 m) and, if more than 100 feet (30 m), will be subdivided into 100-foot (30 m) increments plus any remaining fraction. Any required undergrading to provide a 3-inch (75 mm) bedding of drainage aggregate where geotextile trench lining is omitted will not be included in any calculation of excess depth of excavation for pay purposes.

Average Excess Depth of Excavation	Adjusted Price
0 to 6 inches (0 to 150 mm)	Contract Price
> 6 inches (150 mm)	In accordance with <a href="#">Sec 104.3</a>

**SECTION 605.20 GEOCOMPOSITE PAVEMENT EDGE DRAIN.**

**Description.** This work shall consist of furnishing and installing geocomposite pavement edge drain at the locations shown on the plans or as directed by the engineer.

**605.20.2 Construction Requirements.**

**605.20.2.1** The contractor shall furnish to the engineer a copy of the drain manufacturer's printed instructions for installing the edge drain at least two weeks prior to installation. Except as noted herein, the installation of the drain shall be in accordance with the manufacturer's recommendations.

**605.20.2.2** The contractor shall not install the drain until after all pavement repairs and required undersealing have been completed in the area where the edge drain is to be placed.

**605.20.2.3** Each length of drain shall be joined to the adjacent length prior to installation. Splices shall keep adjoining lengths in proper alignment and shall not separate during installation. Splices shall have the same or greater compressive strength than the geocomposite edge drain, and shall be sealed against infiltration of the backfill material.

**605.20.2.4** The drain shall be placed against the pavement side of the trench and shall be held in place while backfill is placed to a compacted height of 6 inches  $\pm$  one inch (150 mm  $\pm$  25 mm), using a vibratory wheel or plate compactor with a rated impact force of approximately 5000 pounds (34 MPa). The placement of the edge drain and the first lift of backfill shall be accomplished in a single continuous operation. After the first lift of backfill has been placed, the remainder of the backfill shall be placed and compacted by a vibratory compactor to the satisfaction of the engineer. Material excavated from the trench may be used for backfill, except that all backfill shall pass a 2-inch (50 mm) sieve. At the contractor's option, Grade 1 drainage aggregate may be used in two lifts and flooded with clean water to compact each lift. If this method is chosen, the drain shall be placed against the shoulder side of the trench.

**605.20.3 Method of Measurement.** Measurement of geocomposite pavement edge drain will be made to the nearest linear foot (0.5 m) along the centerline of the drain, center to center of fittings and junctions.

**605.20.4 Basis of Payment.** Accepted quantities of geocomposite pavement edge drain will be paid for at the contract unit price per linear foot (m). No overrun or underrun of contract quantity will constitute the basis for contract adjustment. No direct payment will be made for excavating the trench or backfilling and backfill material. Outlet pipes will not be separately paid for, except in combination with any required splash pad.

## **SECTION 605.30 PIPE-AGGREGATE PAVEMENT CROSS DRAIN. .**

**605.30.1 Description.** This work shall consist of placing metal pipe for sub drainage purposes as shown on the plans or as directed by the engineer, and shall include excavating the trench and backfilling with material as specified or directed. Pipe-aggregate pavement cross drains shall be non-continuous and will typically be installed laterally beneath the pavement to improve localized drainage problems. Except as otherwise specified, all cross drains shall have a nominal internal diameter of 6 inches (150 mm) and shall be perforated.

### **605.30.2 Construction Requirements.**

**605.30.2.1** Porous backfill shall extend a minimum distance of shoulder line to shoulder line of flexible pavements and a minimum of 18 inches outside of each edge of rigid pavement.

**605.30.2.2** The pipe shall be firmly bedded in the trench. Dead ends of pipe shall be completely closed by means of caps securely affixed to the pipe. Outlet ends shall be connected to a drain as shown on the plans or as directed by the engineer.

**605.30.2.3** Trenching, placement and backfill of cross drains shall be performed only after Type 1 or Type 5 base is placed and compacted.

**605.30.3 Method of Measurement.** Measurement of pipe-aggregate cross drain will be made to the nearest linear foot (0.5 m) along the centerline of the drain, center to center of fittings and junctions.

**605.30.4 Basis of Payment.** Adjustments in the contract unit price per linear foot (m) of pipe-aggregate cross drain will be made in accordance with the following schedule where the engineer directs increased depth of excavation from that shown on the plans. For purposes of

determining the adjusted price, the excess depth of excavation will be averaged for the entire length of the drain if less than 100 feet (30 m) and, if more than 100 feet (30 m), will be subdivided into 100-foot (30 m) increments plus any remaining fraction. Any required undergrading to provide a 3-inch (75 mm) bedding of drainage aggregate where geotextile trench lining is omitted will not be included in any calculation of excess depth of excavation for pay purposes.

Average Excess Depth of Excavation	Adjusted Price
0 to 6 inches (0 to 150 mm)	Contract Price
> 6 inches (150 mm)	In accordance with <a href="#">Sec 104.3</a>

**SECTION 605.40 STRUCTURAL UNDERDRAIN.**

**605.40.1 Description.** This work shall consist of installing pipe, generally for draining porous or other backfill adjacent to concrete masonry construction, as shown on the plans or as directed by the engineer. The contractor shall select either plastic or metal pipe meeting these specifications, except that geocomposite drains shall not be used and where plastic pipe is used, a concrete splash pad will be required.

**605.40.2 Construction Requirements.**

**605.40.2.1** The pipe shall be laid to the grade and alignment shown. Where a section of pipe is cast into concrete, the remaining pipe shall be joined to these sections with connecting bands. The porous backfill material shall be placed such that the pipe will not become displaced and shall be firmly tamped under and around the entire pipe. Discharge ends shall be protected by approved methods to prevent obstruction until connections to outlets are installed.

**605.40.2.2** When the fill above the drainage system is coarse aggregate or rock fill, Grade 3, 4 or 5, drainage aggregate shall be used with no geotextile. When the remaining backfill is sand or soil, any drainage aggregate may be used with the following exceptions. For sand backfill and Grades 3, 4 and 5, drainage aggregate or for earth backfill and Grades 2, 3, 4 and 5 drainage aggregate, the backfill material shall be separated from the drainage aggregate with geotextile.

**605.40.2.3** After placement of the drain pipe, the initial lift of backfill material shall be placed around and over the pipe to a compacted depth not to exceed 6 inches (150 mm) above the pipe. This initial lift shall be compacted by two passes of a vibrating pad or drum-type compactor approved by the engineer. Any remaining porous backfill shall be placed in loose lift thicknesses not exceeding 6 inches (150 mm) and each lift compacted by two passes of the same equipment.

**605.40.3 Method of Measurement.** Measurement of structural underdrain will be made to the nearest linear foot (0.5 m) along the centerline of the drain, center to center of fittings and junctions.

**605.40.4 Basis of Payment.** Accepted quantities of structural underdrain will be paid for at the contract unit price per linear foot (m). No direct payment will be made for excavating the trench or backfilling and backfill material. Outlet pipes will not be separately paid for, except in combination with any required splash pad.

**SECTION 605.50 FRENCH UNDERDRAIN.**

**605.50.1 Description.** This work shall consist of installing a drain, laterally across a pavement, using a trench, geotextile lining, and Grade 3 or Grade 4 drainage aggregate.

### **605.50.2 Construction Requirements.**

**605.50.2.1** French underdrains shall be constructed in the subgrade and through the shoulders to provide drainage at locations shown on the plans. French underdrains shall have a trench of the dimensions shown on the plans, filled with porous backfill material. For that part of the trench in shoulders, the trench above the porous backfill shall be filled with suitable earth, well compacted.

**605.50.2.2** Unless otherwise specified, both the trench width and depth of drainage aggregate shall be no less than 18 inches (450 mm). Where directed, the trench above the drainage aggregate shall be backfilled with well compacted suitable earth.

**605.50.2.3** Drainage aggregate shall be placed in lifts not to exceed 18 inches (450 mm) in thickness and compacted in a manner meeting the approval of the engineer.

**605.50.2.4** All french underdrains shall be daylighted at discharge ends with minimum 10-foot (3 m) lengths of perforated 6-inch (150 mm) diameter metal pipe placed at or within 3 inches (75 mm) of the flow line.

**605.50.3 Method of Measurement.** Measurement of french underdrain will be made to the nearest linear foot (0.5 m) along the centerline of the drain.

**605.50.4 Basis of Payment.** Accepted quantities of french underdrain will be paid for at the contract unit price per linear foot (m).

### **SECTION 605.60 OUTLET PIPES AND SPLASH PADS..**

**605.60.1 Description.** This work shall consist of furnishing and installing outlet pipes and splash pads for pipe-aggregate pavement edge drain, geocomposite pavement edge drain, and structural underdrain, when four-inch plastic pipe is used, at the locations shown on the plans or as directed by the engineer.

### **605.60.2 Construction Requirements.**

**605.60.2.1** Unless otherwise shown, outlet pipes shall be installed perpendicular to the drain, with a two percent gradient.

**605.60.2.2** Concrete for splash pads shall be air-entrained and Class B, B-1 or concrete of a commercial mixture in accordance with [Sec 501](#).

**605.60.2.3** Construction requirements for the splash pads shall be in accordance with [Sec 609](#). If the excavation is done to neat lines, forming will not be required. Pre-cast splash pads may be substituted for cast-in-place splash pads where approved by the engineer.

**605.60.2.4** Outlet pipes shall be 4-inch (100 mm) diameter, non-perforated, schedule 40 or SDR 23.5 PVC pipe. Outlet connections to pipe-aggregate pavement edge drains shall be with wye connectors or 90-degree elbows as shown on the plans.

**605.60.2.5** Outlet pipe trenches shall not be cut prior to installation of the edge drain. Outlet installation shall be completed promptly and, in all cases, within 72 hours of edge drain installation except with written approval from the engineer. The trench shall not be backfilled until the installation is inspected and approved by the engineer.

**605.60.2.6** Backfilling of excavations for outlet pipe and splash pads shall be performed in accordance with [Sec 203](#). If additional material is needed to complete the backfill, suitable material meeting the approval of the engineer shall be provided by the contractor at the contractor's expense.

**605.60.3 Method of Measurement.** Measurement of outlet pipes and splash pads will be made per each.

**605.60.4 Basis of Payment.** Payment for plan quantity of outlet pipes and splash pads, in combination, will be made at the contract unit price for each of the items included in the contract.