CHAPTER 10 – FOUNDATIONS AND EQUIPMENT PADS

10.1 Standard Plates and Detail Drawings

Standard plates and detail sheets included in the plan contain essential details about the construction and installation of foundations and equipment pads. Standard plates for a project will be listed in the plan. Standard plates that apply to a standalone traffic control signal project are listed on the title sheet of the plan. Standard plates that apply to a standalone lighting project are listed on the quantities sheet of the plan.

Refer to the specific standard plate that applies to the foundation or equipment pad required to be constructed. Current standard plates are available online or upon request from the project engineer.

Standard plates can be revised and updated as design practices and technology changes. Reference the standard plates listed in the plan to ensure the most current standard plates are being used before work begins on any structure.

Detail sheets for both traffic control signal and lighting projects are found in the detail sheets section of the plan.

It is important for the contractor to carry all the contract documents with them at all times during the course of the project since there will be instances where one contract document will reference another contract document. For example, the NOTES section of standard plates and detail sheets may reference a specific area of the MnDOT Standard Specifications for Construction (Spec Book) as presented in Figure 10-1.

Another example is the specification reference box found on the lower right corner of standard plates. The box indicates which specification number(s) in the Spec Book contractors should pay close attention to for technical standards of materials and construction.

Figure 10-1: Example of Standard Plate
Some information found on standard plates and detail sheets includes:

- Type of concrete mix required.
- The diameter of the anchor bolt circle.
- Minimum conduit size and type.
- Number of conduits required in the foundation.
- Reinforcement bar size and placement.
- Minimum projection of the conduit above the foundation top.
- Overall dimensions of the foundation.

Most standard plates and detail sheets contain an area dedicated to “NOTES”. It is essential that these notes be carefully read and understood.

### 10.2 Standard Specification Requirements

#### 10.2.1 GENERAL REQUIREMENTS FOR TRAFFIC CONTROL SIGNAL AND LIGHTING FOUNDATIONS

General requirements used for traffic control signal and lighting concrete foundations and equipment pads are found in Specification 2401 “Concrete Bridge Construction.” Specification 2401 covers a wide spectrum of items, some of which do not apply to traffic control signal and lighting foundations and equipment pads.

Some items that do apply in Specification 2401 are:

- Materials- concrete and reinforcement bars.
- Construction requirements-forms, placement of concrete, compaction of concrete, surface finish, and concrete curing and protection.

Here are a few general requirements for traffic control signal and lighting foundations and equipment pads found in Specification 2401:

- Complete the placement of forms, falsework, bracing, and reinforcement bars for the entire concrete cast and have concrete placement and finishing equipment and curing material on site before placing the concrete.
- Preform mixing, placing, and finishing of concrete under adequate lighting conditions (2401.3C Placement of Concrete).
- Compact concrete using mechanical vibration applied internally. Operate vibrators at a frequency of at least 4,500 impulses per min [75 Hz].
- Provide ordinary surface finish on formed surfaces of concrete structures.
- Maintain a moist surface condition during the curing period (2401.3G Concrete Curing Protection) as shown in Figure 10-6.
Allow at least seven days of curing period to elapse based on 100% design strength for traffic control signal and light foundations and equipment pads before installing poles and service cabinets. Refer to Table 2401-2 in the Spec Book if the concrete surface temperature falls below 70°F to compute the number of curing days required for adequate strength. If the two methods produce different results the engineer will determine if the concrete has cured adequately.

Other standard specification requirements in addition to Specification 2401 used in the construction and installation of traffic control signal and lighting foundations and equipment pads:

- 2411 Minor Concrete Structures
- 2451 Structure Excavations and Backfills
- 2545.3F Concrete Light Foundation and Equipment Pad Installation
- 2565.3 F Concrete Foundations
- 3756 Plastic Curing Blankets
- 3813 Lighting System Anchorages, and 3385 Anchor Rods

Brace foundation and equipment pad conduits, anchor rods, ground rod electrodes, and other equipment in position and at the necessary height with a rigid metal template. Remove the template 24 hours after placing the concrete.
The Engineer will reject foundations if anchor rods, conduits, and ground rod electrodes are improperly aligned after the concrete cures. Do not enlarge bolt holes in transformer base plates to allow shifted anchors or alter the transformer base plate openings to accommodate misaligned conduits and ground rod electrodes.

Figure 10-7: Standard Specification 2565.3F.2

Proper installation of anchor rods, conduits, and ground rod electrodes in foundations is the responsibility of the contractor. Use rigid metal templates that match the bolt pattern and opening of the base plate. Secure the template to the anchor rods to avoid movement during placing and curing of the concrete and ensure proper alignment.

Before placing concrete, tape anchor rod threads that will be exposed above the foundation to prevent contamination by concrete.

As shown in Figure 10-8, clean and brush on an anti-seize and lubricating compound referred to as “bridge grease” to the exposed threads of all anchor rods (bolts) and nuts and the bearing surface of all nuts and washers just before installing signal service cabinets, mast arm poles, pedestals, light poles, lighting service cabinets, or other types of structures on anchor rods.

Bearing surface means the plane of contact between the washer and the nut or bolt head being turned when tightening the anchor rod (bolt) connection. Up to 70% of the friction of an anchor rod connection comes from turning the nut against the washer. Use bridge grease on bearing surfaces and threads of nuts and anchor rods to reduce friction when tightening the connection.

Ensure a clean work area to prevent dirt from contaminating bridge grease on nuts, washers, and anchor rods. Contaminants will cause friction between the anchor rod and nut and therefore impede nut rotation to achieve proper tightening of the connection.
Clean anchor rods, nuts and washers and re-apply bridge grease if more than 24 hours has passed since earlier application or the anchor rods, nuts, or washers have become wet after applying bridge grease.

Provide foundation and equipment pad anchor rods in accordance with Specifications 3813 Lighting System Foundations and 3385 Anchor Rods. Standard plates and detail sheets may specify type of anchor rod material.

Specification 3385 requires galvanized Type A, Type B, and Type C anchor rods to have the ASTM F1554 specification supplementary requirement S3 for permanent grade identification.

ASTM F1554 S3 states that instead of color coding as specified within ASTM 19.1, the end of the anchor rod intended to project from the concrete shall be steel die stamped with the grade identification as represented in Figure 10-9 and as follows: Grade 36=AB36, Grade 55=AB55, Grade 105=AB105.

In addition to the required permanent grade identification on the end of the anchor rod, color coding may be allowed to help facilitate easy identification in the field but it is not required.

Specification requirements may become outdated in the Spec Book. Therefore, it is essential that the contractor and the inspector check other contract documents, such as the special provisions for the project, for any updated or revised requirement language to the construction and installation of foundations and equipment pads before work begins on any structure.

10.3 Construction of Traffic Control Signal Foundations and Equipment Pads

Traffic control signal concrete foundations are drilled shaft foundations. Drilled shaft foundations are used because of their very high load capacities. A drilled shaft foundation is a cylindrical excavation in soil filled with concrete. The concrete is placed in the shaft without a permanent forming tube so the concrete comes in contact with the surrounding soil for the primary purpose of structural support.

One of the most important aspects of the interaction between the concrete and the surrounding soil is that it creates a resistance to lateral force or load, such as lateral resistance to wind. Unless soil conditions do not allow, use a fiber forming tube only on the upper portion of the foundation in accordance with contract documents so the remainder of concrete foundation will be in contact with the surrounding soil of the drilled shaft.
The drilled shaft is most commonly constructed by using rotary drilling equipment to drill a cylindrical hole.

The concrete may be placed by free fall in shafts if the mix is carefully designed to ensure that the excavation is filled and segregation is minimized. Free fall is defined as concrete falling through air. Therefore, the concrete must not fall through the rebar cage or strike the sides of the excavation.

In some instances, spread footing foundations or altering the foundation design may be necessary with approval from the engineer.

Carefully read all contract documents (special provisions, detail sheets, standard plates, Spec Book) before installing foundations to ensure all requirements are met.

The following pages describe in more detail, specific foundations and equipment pads commonly used in MnDOT traffic control signal construction. The standard plates, detail sheets, and other contract documents shown in the following pages are for informational purposes only. Consult the project’s contract documents for the most accurate and up-to-date standard plates, Spec Book standards, special provisions, and detail sheets.
10.3.1 MAST ARM POLE FOUNDATION (STANDARD PLATES 8120 & 8126)

Standard Plates 8120 and 8126 are the approved standard details for PA85, PA90 and PA100 pole foundations. These pole foundations are drilled shaft foundations that contain a rebar cage and are designed to handle the stresses of a large pole and mast arm up to 55 feet in length depending on the foundation type chosen.

The required minimum depth of a PA100 pole foundation is 12 feet below ground.

The length of foundation extending above the ground line or top of walk area must be a minimum of 6 inches; “the elevation of the top of the foundation must assure the vertical clearance from the bottom of all signal heads (including background shields) to the pavement is not less than 17 feet nor greater than 19 feet”.
There are three ways to calculate foundation depth:

1. By identifying the type of soil. This can be done by looking at the Grading and Base Manual, Soil Classification Section (600 series section).
2. By calling the Soils Engineer.
3. By drilling the foundation to the minimum required depth in the standard plate.

The rebar cage must be placed in the center of the foundation 6 inches from the top and a minimum of 3 inches from the sides.
MnDOT uses two types of mast arm poles: Type A (more commonly used) and Type B. The types of poles required for each project are listed in the pole notes on the intersection layout sheet of the plan. The locations of the mounting hubs for shaft-mounted signal heads differ according to the pole type. To determine the proper orientation of the anchor rods for the two types of mast arm poles, refer to the vertical section of Standard Plate 8126.

The PA pole foundations are drilled shaft foundations that require the concrete to be poured directly against soil of the drilled shaft with the primary purpose of structural support. Use a continuous fiber forming tube for only the upper portion of the foundation above grade and maximum 4 feet below grade if the sidewalls of the drilled shaft remain firm and stable.

If soil conditions do not allow the sidewalls of the drilled shaft to remain firm and stable a continuous full length forming tube with four rectangular holes cut as indicated may be used with the approval of the engineer.

The following information in Figure 10-13 and 10-15 are a copy of updated installation requirements found in the 2018 Standard Specifications for Construction Section 2565.3.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Depth of Rectangular Holes Below Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6 ft-7 ft</td>
</tr>
<tr>
<td>2</td>
<td>4 ft-5 ft</td>
</tr>
</tbody>
</table>

* Refer to The Office of The Revisor of Statutes website for frost depth zone requirements, Minnesota Administrative Rules 1303.1600 Footing Depth for Frost Protection, https://www.revisor.mn.gov/rules/?id=1303.1600 to determine appropriate frost depth zone.

Figure 10-13: Installation Requirements for Pole Foundations from Special Provisions for Signals
During placement of the concrete, ensure concrete fills the shaft area and any void area outside the fiber forming tube that is below grade.

If soil or rock conditions not suitable for standard foundations are present, or if conditions are marginal, contact the MnDOT Bridge Evaluation and Fabrication Methods Engineer and the MnDOT Foundations Unit for a foundation design that can be used as an alternative to the standard foundation design.

Foundation design is based on installing in a drilled shaft. Any variation to the drilled shaft requires an approval by the District Soils Engineer. If a drilled shaft foundation is not possible obtain approval from the District Soils Engineer to conduct open excavation for the foundation before starting the work.
10.3.2 POLE FOUNDATION TYPE BA (STANDARD PLATE 8134)

Pole foundation type BA is designed for traffic control signal poles with mast arms 60 feet to 80 feet.

The mast arm length determines drilled shaft depth, anchor bolt diameter, and bolt circle diameter of the pole foundation.

Pole foundation type BA is either a drilled shaft foundation or spread footing foundation.

Figure 10-16: Pole Foundation Install

Figure 10-17: Pole Foundation Type BA Notes
10.3.3 PEDESTAL FOUNDATION (STANDARD PLATE 8112)

The pedestal foundation is a concrete cast in-place foundation designed for the Pedestal and Pedestal Base Standard Plate 8112 for traffic control signals.

Use the required washers shown on Standard Plate 8129 for the pedestal foundation anchor bolts and pole base connection assembly.

The pedestal base for the foundation has been tested and approved for breakaway by the FHWA. Ensure the projection of the foundation does not exceed more than a 1/4 inch above the concrete sidewalk or finished grade and the anchor bolts do not project more than 3 3/4 inches above the top of the foundation. These projection specifications must be followed to meet the ADA maximum of 1/4-inch surface vertical change and AASHTO breakaway 4-inch maximum stub height requirements.

![Diagram of Pedestal Foundation](image)

**Figure 10-18: Pedestal Foundation**
There is an option to use an approved Screw-In Design Steel P foundation for pedestal poles if allowed by the district traffic office. Consult with the project’s Division SS Special Provisions for the option to use a steel screw-in foundation instead of a concrete foundation on the project.

If there is an option to use Screw-In Design Steel P foundations then there will be steel screw-in foundation specification language in Division SS Special Provisions and a Screw-In Pedestal Pole Foundation-Design Steel P detail installation sheet included in the plan for the project. The detail installation sheet can be found on MnDOT’s Traffic Engineering Signals web page in “Signal Plan Sheets” under “Detail Sheets”.

The approved Screw-In Pedestal Pole Foundation-Design Steel P can be found on MnDOT’s Approved/Qualified Products List (APL) for roadway lighting products, light foundations, called Design P Lighting Foundation.

10.3.4 APS PUSH BUTTON STATION FOUNDATION
The APS push button station foundation design facilitates ease of construction, mainly the flatwork, while still providing a rigid foundation for the APS push button base to breakaway properly.

The anchor rods for the foundation are 5/8 inch UNC X 7 1/2-inch stainless steel threaded rod. Drill four 3/4 inch holes 6 inches deep and insert rods using an approved epoxy found on MnDOT’s APL. Anchor rod maximum projection height above the concrete is 1 1/2 inches.

For more information on the installation of the epoxy anchor rods refer to Chapter 18 APS push buttons.

Ensure edge of sidewalk and all sidewalk joints are a minimum of 9 inches from center of the APS push button station foundation.
The APS push button station foundation is a monolithic concrete structure, meaning the foundation is constructed in combination with the sidewalk making it all one structure.

Before placing concrete, grade a 1:2 (V:H) slope where the 6-inch sidewalk will transition to the minimum 12-inch foundation hole depth. If the foundation will not be located near the edge of the sidewalk and instead surrounded by concrete walk, then grade the 1:2 slope 360 degrees for the sidewalk to foundation transition.

Maintain a compacted aggregate bedding and thickness used for sidewalk for the foundation.

An 18 inch X 6-inch fiber forming tube may be used for the lower half of the foundation when conditions do not allow for the hole to stand open.

10.3.5 SSB CABINET EQUIPMENT PAD (SSB CABINET LAYOUT DETAIL SHEET)
The SSB cabinet equipment pad supports both the SSB service cabinet and the controller cabinet.
See Appendix for the entire typical signal plan equipment pad layout detail.

Placement of conduit to the left of the SSB service cabinet divider is critical. Make sure the conduits are positioned correctly in the pad so they align with the assigned line and load side sections of the cabinet.

![Figure 10-23: Cabinet Pad Detail](image1)

Install two ground rods, one in the pad and the other located a minimum of 8 feet outside of the pad. Bond the two ground rods together with one continuous length of un-spliced insulated grounding conductor from the outer most ground rod to the ground bus bar in the cabinet.

![Figure 10-24: Conduit Placement on Pad](image2)

Bond one end of an insulated grounding conductor to the rebar cage before the concrete is poured. Terminate the other end to the cabinet ground bus bar.
10.4 Construction of Light Foundations and Equipment Pads

There have been recent changes in the construction and installation of MnDOT light foundations and equipment pads. Some of these changes are mentioned in this chapter. Please take time to review the material in the following pages to become familiar with important details and requirements. The following standard plates, details, and contract document language in these pages are for informational purposes only. Always consult the project’s contract documents.

Cast in-place light foundations are drilled shaft foundations. A drilled shaft foundation is cylindrical excavation in soil filled with concrete. When possible, place the concrete in the shaft without a permanent forming tube so the concrete comes in contact with the surrounding soil for the primary purpose of structural support. A forming tube may be used for the upper portion to help position the conduits and form the top of the foundation. If the surrounding soils do not allow the drilled shaft to stand open then a forming tube will be required.

Compaction around precast light foundations has been a problem in recent years for MnDOT. Precast light foundations are now required to be installed in drilled shafts (augured holes). The space between the drilled shaft and foundation will be filled with a specific backfill material in accordance with contract documents.

The drilled shaft for both cast in-place and precast is most commonly constructed by using rotary drilling equipment to drill a cylindrical hole.

Districts may allow the use of steel screw-in foundations instead of cast in-place or precast foundations. Check the project’s contract documents to see if steel screw-in foundations can be used.

MnDOT recently approved a new type of steel screw-in foundation with a helix found on MnDOT’s APL. The helix type foundation is the only approved type that can be used for permanent lighting.
There have been several changes in how and where steel screw-in foundations are installed. Be sure to read contract documents before acquiring and installing steel screw-in foundations.

All MnDOT service equipment pads now require two ground rod electrodes to be installed, one in the pad and the other not less than 8 feet from the pad. If the pad has a reinforcement bar, it must be bonded to the ground bus bar in the service cabinet.

Carefully read all contract documents (special provisions, detail sheets, standard plates, Spec Book) before installing foundations and equipment pads to ensure all requirements are met.

**10.4.1 LIGHT FOUNDATIONS DESIGN E AND H (STANDARD PLATES 8127 AND 8128)**

Light foundation Design E is designed for 40-foot light poles. Light foundation Design H is designed for 49-foot roadway light poles. Both Design E and H foundations can be cast in-place concrete, precast concrete, or steel screw-in as specified in contract documents.
Each foundation type has specific construction and installation requirements, some of them recently new. Be sure to check all the contract documents (standard plates, details, Spec Book, and special provisions) before installing foundations.

The following information provides some details and requirements for Design E and H light foundation types.

**Cast In-Place**

Cast in-place light foundations are drilled shaft foundations designed to be constructed in drilled shafts (augured holes) with the concrete poured directly against the surrounding soil of the shaft.

If soil conditions do not allow the shaft to stand open a fiber forming tube will be required.

Wet-cast a 15-foot-long ground rod electrode in the foundation as shown in the standard plate.

Conduits with end bells shall project a minimum 1/4 inch to a maximum 1 inch above the foundation.

Conduit ends require end bells. Be sure to install the end bells on the foundation conduits before pouring the concrete. A standard 2-inch end bell height is 1 1/2 inches. If end bells are installed on the conduits after the concrete has been poured, the conduit height with bell end will exceed the required maximum 1 inch projection above the foundation.
Precast Foundation (Standard Plates 8127 and 8128)

A 1 inch PVC conduit is required to be installed in a precast foundation. The conduit is a raceway for the 6 AWG solid bare copper wire from the 15-foot ground rod electrode.

The top of the 15-foot ground rod electrode is installed within 1 foot of the foundation and 3 inches to 6 inches deep below ground line.

For years, compaction around precast light foundations has been an issue. There are now new requirements for installing precast light foundations in 2545.3.F.2.a that should help alleviate this problem.
Steel Screw-In

Steel screw-in foundations may be used as an alternate to the concrete foundations if allowed by the district traffic office and in contract documents.

The MnDOT approved steel screw-in foundations are found on MnDOT’s APL.

Before placing an order for steel screw-in foundations, determine soil classification and review soil conditions on the project as required in special provision language.

Installers of steel screw-in foundations on the project are recommended to be trained and certified by the steel screw-in foundation manufacturer.

A hydraulic drive head with a gear motor minimum torque rating of 15,000 ft lbf is required to install steel screw-in foundations.

The MnDOT approved Design E and H steel screw-in foundations have a pilot point, helix, and drilled and tapped threaded holes in the base plate for full thread hex head anchor bolts.

The tapped threaded holes in the base plate with the full thread hex head anchor bolts allows for:

1. Poles that do not require leveling nuts to be installed on steel screw-in foundations.
2. The H Design with 49 foot poles to be used because it meets the AASHTO 4 in maximum breakaway support requirement when the foundation is installed flush with ground level.

The use of steel screw-in light foundations on construction projects will be approved by the district traffic office. If there is an option to use steel screw-in light foundations then there will be steel screw in foundation specification language in Division SL Special Provisions and a steel screw-in light foundation Design E & H detail installation sheet in the plan for the project.
The following information in Figure 10-35, Error! Reference source not found., Error! Reference source not found., Error! Reference source not found., 40 are copies of the 2018 Roadway Lighting Special Provision language and a copy of the steel screw-in light foundation Design E &

MATERIALS

A. Light Foundation-Design E Steel Screw In

Light Foundations- Design E Steel Screw In may be used instead of concrete Light Foundations- Design E Standard Plate 8127. Provide Light Foundations- Design E Steel Screw In listed on MnDOT’s Approved/Qualified Products List under “Roadway lighting”.

http://www.dot.state.mn.us/products/index.html

Installers of steel screw in foundations are required to be trained and certified every two years by the manufacturer or the manufacturer’s representative of an approved steel screw in foundation listed on MnDOT’s Approved/Qualified Products List. Before starting steel screw in foundation installation, submit a current certified installer card issued by the manufacturer for each employee directly performing the installation.

Ensure the soil class types and soil conditions on the Project are acceptable and suitable for proper support and long term stability of steel screw in light foundations.

Before placing an order for steel screw in foundations:

1. Contact the District Soils Engineer to access the Project’s;
   (1.1) Soils Logs,
   (1.2) Plans with borings, and
   (1.3) Soils Test Reports,

2. Review the Soils Classification for Steel Screw In Foundation Installation table in the Construction Requirements section for acceptable and suitable soils for steel screw in foundations,

3. Perform an onsite field review of the soils and general locations where light foundations will be installed on the project,

4. Review the Plans for lighting unit foundations surrounded by concrete or bituminous (e.g., placed in sidewalk or a parking lot), and

5. Review the Construction Requirements section for Light Foundations-Design E Steel Screw In.

If there are no project soils logs, borings, and soils test reports, then provide to the District Soils Engineer the control section of the Project to reference materials design reports from past projects that are within the general area of the Project. If no soils information for the Project can be obtained, then soils testing is recommended at no cost to the Department.

Provide the soils information obtained from the District Soils Engineer or the recommended soils testing, and the onsite field review to the Department upon request.

Install concrete light foundations, design type as shown on the Plans, at no additional cost to the Department if the District Traffic Office determines the soil conditions or the placement of the staked locations are not suitable for steel screw in foundations.

Install concrete light foundations, design type as shown on the Plans, where Design E or H foundations will be surrounded by bituminous or concrete.

Figure 10-35: Roadway Lighting Steel Screw in Foundation Special Provisions

Foundations and Equipment Pads
Install Light Foundations Design__ Steel Screw In listed on MnDOT’s Approved/Qualified Products List under “Roadway lighting” in accordance with the manufacturers recommended installation instructions, details in the Plan, 2545.3 F.2 “Light Foundations”, 2451 “Structures Excavations and Backfills”, and the following:

Use a hydraulic drive head with a gear motor minimum torque rating of 15,000 ft lbf to ensure sufficient clockwise torque and downward pressure when installing foundations into the ground. A two speed drive head is recommended.

To prevent possible damage to the foundation do not exceed a torque capacity of:

(1) 20,000 ft lbf for a Light Foundation Design E and P, and
(2) 30,000 ft lbf for a Light Foundation Design H

The Department may require a torque measuring device to measure the installation torque to ensure maximum torque values are not exceeded.

Install foundations into undisturbed ground unless predrilling has been approved.

Figure 10-36: 2016 Roadway Lighting Steel Screw in Foundation Special Provisions
<table>
<thead>
<tr>
<th>Class</th>
<th>Common Soil-Type Description</th>
<th>Geological Soil Classification</th>
<th>Typical Blow Count “N” per ASTM –D1586</th>
<th>Installation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Sound hard rock, unweathered</td>
<td>Granite, Basalt, Massive Limestone</td>
<td>N.A.</td>
<td>Do not install, not acceptable or suitable for steel screw-in foundations</td>
</tr>
<tr>
<td>1</td>
<td>Very dense and/or cemented sands; coarse gravel and cobbles</td>
<td>Nitrate-bearing gravel/rock</td>
<td>60-100+</td>
<td>Acceptable for steel screw-in foundations. *Pre-drill likely required in Class 1, 2, and 3 soils before installing steel screw in foundations</td>
</tr>
<tr>
<td>2</td>
<td>Dense fine sands; very hard silts and clays (may be preloaded)</td>
<td>Basal till; boulder clay; weathered laminated rock</td>
<td>45-60</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Dense sands and gravels; hard silts and clays</td>
<td>Glacial till; weathered shales, schist, gneiss and siltstone</td>
<td>35-50</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Medium dense sands and gravels; very stiff to hard silts and clays</td>
<td>Glacial till; hardpan; marls</td>
<td>24-40</td>
<td>Class 4, 5, 6, and 7 soils are suitable for installing steel screw-in foundations. *Class 4 may require predrill before installing steel screw in foundations</td>
</tr>
<tr>
<td>5</td>
<td>Medium dense course sands and sandy gravels; stiff to very stiff silts and clays</td>
<td>Saprolites, residual soils.</td>
<td>14-25</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Loose to medium dense fine to coarse sands to stiff clays and silts</td>
<td>Dense hydraulic fill; compacted fill; residual soils.</td>
<td>7-14</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Loose fine sands; alluvium; loess; medium-stiff and varied clays; fill</td>
<td>Flood plain soils; lake clays; fill</td>
<td>4-8</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Peat, organic silts; inundated silts, fly ash, very loose sands, very soft to soft clays</td>
<td>Miscellaneous fill, swamp marsh</td>
<td>0-5</td>
<td>Do not install, not acceptable or suitable for steel screw in foundations</td>
</tr>
</tbody>
</table>

* Pre-drill may be allowed in Class 1, 2, 3 and 4 soils.
Pre-drill in certain soil types as specified in the Soil Classification for Steel Screw In Foundation Installation table in this section may be allowed when soils are difficult. Obtain Engineer’s approval before predrilling.

Predrill the area of install meeting the following requirements:

(1) Pre-drill without removing the soil,
(2) Use an auger with a maximum diameter of:
   (2.1) 6 in for a Light Foundation Design E and P,
   (1.1) 8 in for a Light Foundation Design H,
(3) Drill no deeper than the length of the foundation, and
(4) Before installing steel screw in foundations place the soil back in holes to the level of the surrounding ground surface. Do not compact soil.

Do not install steel screw in foundations in pre-excavated holes or drilled shafts.

Do not install steel screw in foundations in frozen soils.

Original staked locations for foundations may be moved no more than 10 feet in either direction parallel to the roadway to secure a more desirable location when soil conditions are questionable, or very dense or difficult. Obtain approval from the District Traffic Office before moving staked locations.

When rock or other conflicts are encountered during the installation process that prevents the foundation from being installed in accordance with contract documents, relocate the foundation 5 feet to 10 feet in either direction parallel to the roadway from the originally staked location.

Backfill unused holes made during steel screw in foundation installation attempts.

Install a concrete light foundation, design type as specified in the Plan, if the District Traffic Office determines the soil condition or the placement of the staked location is not suitable for a steel screw in foundation. Installation of the concrete light foundation is at no additional cost to the Department.

Install concrete light foundations, design type as specified in the Plan, where Design E and H foundations will be surrounded by bituminous or concrete.

Install preformed joint filler between concrete and the steel screw in foundation, where a Design P foundation will be surrounded by concrete.

Turn the foundations so that mast arms and davits of light poles are perpendicular to the centerline of the roadway unless specified elsewhere in contract documents.

Turn the foundation shaft cableways parallel with the roadway unless specified elsewhere in contract documents or when directed by the Engineer. Use the notched cableway indicators located on the top of the foundation base plate to achieve the required placement of shaft cableways.

As the foundations are screwed into the ground ensure the shaft alignment is within a tolerance of 1/4 in per 5 feet of depth. Install foundations plumb. Ensure the foundation base plate is level from side to side and front to back and the top of the foundation is flush with the ground line when the installation is complete.

Backfill and compact the cable or conduit trench.
If bedrock is encountered that prevents the drilled shaft from reaching the designed depth for the foundation, contact the MnDOT Bridge Evaluation and Fabrication Methods Unit for a foundation design that can be used instead of a standard light foundation Design E or H.

Place ground rods electrodes in accordance with 3818 and applicable section of 2565.3H.5 at locations indicated in the plan.

Currently there are no approved standard details for a Rock 40 or 50 light foundation. Foundations will be designed per project.
10.4.3 BRIDGE AND BARRIER LIGHT FOUNDATIONS (STANDARD PLATES 8308, 8309, AND 8332)

MnDOT bridge and barrier light foundations have six anchor bolts and are designed for 40 feet and 50 feet, single and double davit steel light poles with two access doors.

It is absolutely imperative that the anchor bolt cluster cage is installed in the barrier with the required 5 to 6-inch bolt projection above the foundation.

If the foundation bolt projections are less than 5 inches, and the pole cannot be installed as required, the engineer will reject the foundation in accordance with 2565.3F.2.

Do not install poles that require leveling nuts directly on the concrete barrier foundation. Do not use heavy hex jam nuts for leveling nuts.

Although the anchor bolt cluster is a cage, a rigid metal template is still necessary to help align conduits and the ground rod electrode to ensure they fit inside the bottom opening of the pole base.

Figure 10-39: Anchor Bolt Cluster and Base Plate for Light Poles
10.4.4 EQUIPMENT PAD B CAST IN-PLACE AND PRECAST (STANDARD PLATE 8106)

The most common equipment pad used on MnDOT lighting systems is the equipment pad B Standard Plate 8106. The pad is designed to support L1 and L2 lighting service cabinets.

The equipment pad can be either cast in-place or precast. For cast in-place pads use the anchor rods supplied with the service cabinet. For precast provide anchor rods as shown on the standard plate and insert in drilled holes in the pad with an approved epoxy adhesive used for the APS push button foundation found on MnDOT’s APL.

Do not use mechanical anchor bolts or concrete wedge anchors for cast in-place or precast pads.

The conduits must line up with the bottom openings of the cabinet. Altering the cabinet structure to fit the conduits will not be accepted.

Both types of equipment pads require two ground rod electrodes. The precast pad reinforcement bar is also bonded to ground. See Standard Plate 8106 for more details on Grounding Electrode System for the cast in-place and precast pads.

Figure 10-40: Barrier and Glare Screen

Figure 10-41: Equipment Pad B Details
10.4.5 RLF EQUIPMENT PAD CAST IN-PLACE AND PRECAST (STANDARD PLATE 8107)

The RLF equipment pad is designed to support a Type Rural Lighting and Flasher (RLF) service cabinet.

The equipment pad can be either cast in-place or precast. For cast in-place pads use the anchor rods supplied with the service cabinet.

For precast use anchor rods shown on the precast standard plate. Insert the anchor rods into drilled holes in the pad with an approved epoxy adhesive used for the APS push button foundation found on MnDOT’s APL.

Do not use mechanical anchor bolts or concrete wedge anchors for cast in-place or precast pads. Do not wet cast anchors for precast pads.

A grounding system is required for both cast in-place and precast pads in accordance with 2545.3F.3. Use the grounding system detail shown on sheet 3 of Standard Plate 8106 Equipment Pad B.

In the precast pad the two layers of rebar mat must be bonded together using a solid 6 AWG bare copper conductor. The copper conductor must be all one piece (no splices) with a minimum of 5 feet of exposed length out of the concrete from the 10 inch X 10-inch hole. This installation takes place at the precast facility.
10.4.6 LIGHT FOUNDATION GRADING ON ROADSIDE

All MnDOT roadside light pole foundations located in the clear zone are required to be installed flush with the ground line to prevent a vehicle from snagging on either the foundation or the anchor rods. When foundations are installed on roadside slopes, install in accordance with the most current edition of AASHTO LRFD Specifications and as follows:

“Foundations placed on roadside slopes must not allow impacting vehicles to snag on either the foundation or anchor rods. Shape the terrain around the foundations to ensure anchor rods do not project more than a maximum of four (4) inches above a horizontal line between the straddling wheels of a vehicle on 60 inch centers. The horizontal line from wheel to wheel connects any point on the ground surface on one side of the light standard foundation including anchor rods to a point on the ground surface on the other side of the light standard foundation including anchor rods. The horizontal line is aligned radially or perpendicular to the centerline of the roadway.” (2545.3F.2 Light Foundations)

**Figure 10-45: RFL Equipment Pad Foundation Layout**

**Figure 10-46: Lighting Placement Detail**
To prevent soil erosion and wash-out around foundations use erosion control products to reinforce vegetation in accordance with 3885, “Rolled Erosion Control Products”.

### 10.5 Signal and Lighting Standard Plates, Details, and APL Products

#### LIGHTING STANDARD PLATES

- Equipment Pad B
- RLF Equipment Pad
- Light Foundation–Design E
- Light Foundation - Design H
- Shim and Washer
- Reinforced Concrete Median Type F (Non-Glare Screen Type)

- Reinforced Concrete Median Type F and Glare Screen
- Anchor Bolt Cluster and Base Plate for Light Poles

#### SIGNAL DETAIL SHEETS

Steel Screw-In Light Foundation Design E & H Installation Detail Sheet
[http://www.dot.state.mn.us/trafficeng/lighting/index.html](http://www.dot.state.mn.us/trafficeng/lighting/index.html)

Steel Screw-In Light Foundation Design P Installation Detail Sheet
[http://www.dot.state.mn.us/trafficeng/lighting/index.html](http://www.dot.state.mn.us/trafficeng/lighting/index.html)
APPROVED/QUALIFIED PRODUCTS LIST (APL) ROADWAY LIGHTING
Steel Screw-In Light Foundations Design E, H & P

SIGNAL STANDARD PLATES
Pedestal Foundation......................................................... ........................................ 8121
Pole Foundation (PA85, 90 AND 100)............................................. ......................................... 8126
Pole Foundation Type BA......................................................... ........................................ 8134

SIGNAL DETAIL SHEETS
APS Push Button Station Detail
http://www.dot.state.mn.us/trafficeng/signals/signalplansheets.html

SSB Cabinet Pad Layout
http://www.dot.state.mn.us/trafficeng/signals/signalplansheets.html

10.6 Chapter 10 Resources
- MnDOT Approved/Qualified Products List (APL)
- MnDOT Standard Specifications for Construction 2401, 2411, 2451, 2545.3F, 2565.3H.5, 3756, 3813, 3813, 3385, 3818
- Standard Plates (listed above)