Precast Concrete Manhole Installation

Recommendations of ASTM C1821 and the NPCA
Buried Infrastructure is Critical
ASTM C1821-16 Installation of Underground Circular Precast Concrete Manhole Structures

• Scope
• Referenced Documents
• Terminology
• Significance and Use
• Site Inspection
• Planning
• Delivery
• Safety Requirements
• Excavation and Shoring
• Foundation
• Leveling Course
• Manhole Installation and Joining
• Testing
• Keywords

Or included within the NPCA Selected ASTM Standards for Precast and Prestressed Concrete
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Section 6: Planning

6.6: As required by the owner, engineer, installer or manhole manufacturer shop drawings shall be prepared for approval prior to fabrication. The shop drawings shall include, but not limited to detailed information describing each structure component to be fabricated and the associated assembly of the manhole structures by the installing contractor.

6.6.1: Shop drawings shall also include steel layout details of any specialty items including flattop slabs, flattop reducing slabs, base sections, special barrel section openings, reducer cones.

6.6.2: The shop drawings shall include certification of compliance to the project plans and specifications or clearly note any specific exceptions to the same.
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Manhole Project Installation

Delivery Time!
Section 7: Delivery

7.1: Manufacturer shall verify manhole components are in compliance to approved shop drawings prior to shipment to the project site.

7.2: The installer shall inspect the manhole components for damage during shipping and unloading, and any non-compliance to approved shop drawings.
Section 7: Delivery

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Section 8: Safety Requirements

- **8.2:** Manhole components shall only be handled with appropriately rated handling equipment from the safe lift points designated by the manufacturer of the precast manhole sections. Manhole ladders, steps or appurtenances are not to be used as lifting points.

- **8.2.2:** When lifting manhole bases and risers, make sure the chain or cable lengths are long enough to prevent contact with the manhole joint area and are kept at appropriate lifting angles. Where safe lifting angles cannot be achieved, use appropriately rated spreader bars.
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Lifting with a spreader bar
Lifting with a spreader bar

Vs.

Lifting with a spreader bar
ASTM C1821/C1821M

Section 7: Delivery

• 7.2.4: If manhole product(s) need to be stored onsite, it is the installer’s responsibility to ensure the product is placed on level ground and free from unnecessary mud or debris to prevent damage to the manhole components.
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• 7.2.4: If manhole product(s) need to be stored onsite, it is the installer’s responsibility to ensure the product is placed on level ground and free from unnecessary mud or debris to prevent damage to the manhole components.
• **7.2.1:** If any damage or non-compliance is identified, the installer shall take corrective action by notifying the manufacturer. Upon inspection if the damage may affect the performance of the manhole structure, the area shall be repaired in accordance with Specification C478. If the damaged manhole component cannot be repaired in accordance with Specification C478, that component shall not be installed.
Section 7: Delivery

• 7.2.1: If any damage or non-compliance is identified, the installer shall take corrective action by notifying the manufacturer. Upon inspection if the damage may affect the performance of the manhole structure, the area shall be repaired in accordance with Specification C478. If the damaged manhole component cannot be repaired in accordance with Specification C478, that component shall not be installed.
• **7.2.2:** The installer shall measure the received manhole components upon delivery to verify the products furnished are in compliance with the approved shop drawings. This includes but is not limited to: pipe hole placement to confirm pipe entrance and exit angles are correct; the distance from the exterior bottom of the manhole base to the hole placement; and corresponding pipe invert elevation to calculate and verify required excavation elevations to maintain pipe grade to project requirements. Verify the manhole components supplied can be constructed to the correct finished grade elevation with components furnished prior to installation. Any identified issues with any of these items shall be reported immediately to the precast manhole manufacturer.
Section 7: Delivery

7.2.4: Special joint materials: gaskets, lubricant, mastic if furnished shall be stored securely and in accordance with manufacturer’s recommendations.
ASTM Manhole Installation

Part 2 – Excavation & Bedding Preparation
Section 6: Planning

6.2: All utilities and owners of surface and subsurface facilities and structures in the area shall be given advance notification of proposed excavation directly by the installer or at a designated pre-construction meeting.
Section 6: Planning

• 6.4: Prior to ordering of the manhole components the installer shall review all proposed manhole installation locations on the project with the design engineer and identify any potential conflicts or reasons for movement of the manhole to a more appropriate location. If a conflict is identified onsite prior to excavation or while performing layout, the engineer shall be notified immediately to propose alternative location and to provide the precast manhole producer the opportunity to alter production of the manhole structure.
Section 9: Excavation and Shoring

- **9.4:** Shoring if utilized for construction shall be in accordance with all national, regional and local regulations.

- **9.5:** If shoring is to be removed it shall be done in accordance with the shoring manufacturer’s recommendations or approved safe construction practices. The installer shall use the appropriate lifting equipment to safely remove the shoring and to prevent any disturbance or damage to the manhole.

- **9.6:** Voids in the sidefill that are created by movement of the shoring shall be filled and compacted in accordance with 12.7.
Section 10: Foundation

• **10.1:** The foundation shall be moderately firm to hard in situ material, stabilized soil, or compacted fill material with adequate bearing capacity to support the manhole structure as specified by the engineer or project requirements.

• **10.2:** When unsuitable or unstable material is encountered, the foundation shall be stabilized or removed and replaced with firm and stable foundation material with adequate bearing capacity to support the manhole structure.

• **NPCCA Guidelines:** Use a minimum of 6 inches of approved bedding material compacted to 90% proctor in an area not less than the base area but preferably 6 inches beyond the outside radius of the manhole base.
Section 11: Leveling Course

- **11.2:** A minimum 3 inches [75 mm] thick leveling course in an area not less than manhole base area but preferably 6 inches [150mm] beyond the outside radius of the manhole base, as shown in Figure 1. The nominal maximum aggregate size within the leveling course shall not be greater than 1 inch.

- **10.3:** Manhole sections installed over an unyielding foundation, including concrete, shall be cushioned so as to prevent non-uniform bearing in accordance with Section 11.
Section 11: Leveling Course

- **11.5:** The soil levelling area under the manhole structure shall be of uniform stiffness and thickness to the project specifications with even compaction throughout. Local ground conditions may require additional leveling course thickness per project specifications, the engineer's recommendations, or the installers judgment.

- **NPCA Guidelines:** Use a minimum of 3 inches of approved granular material loosely placed in an area not less than the base area but preferably 6 inches beyond the outside radius of the manhole base.
11.6: The soil foundation area or bedding under incoming and outgoing pipes should be treated the same as the manhole base section to prevent settlement or shearing of pipes and to provide proper alignment for the watertight connector/pipe interface if resilient rubber connectors are being used.

Field drawing of a manhole showing rim and flow line elevations and section heights.
ASTM Manhole Installation

Part 3 – Installing and Joining
Section 12.3: Manhole Placement

• **12.3.1:** Set the manhole base on the leveling course making sure the manhole base section is firmly in place and the connectors or pipe openings match design orientation. Verify the top of the manhole base is level in two directions perpendicular to each other.

• **12.3.2:** Verify the manhole base section pipe openings and/or connectors are at proper grade for pipe inverts to match design elevations.

• **12.3.3:** Assemble multi-section manhole structures by lowering each section into the excavation. As they are installed, verify each additional riser section is plumb and the joint homed before installing the next riser, conical top or flat slab top.
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Section 12.3: Manhole Placement: **Alignment**

Get the first one right!

**Typical tolerance**

- 2 inches per 16 feet

There is no consensus on permissible plumb tolerance. It is the responsibility for the authority having jurisdiction to specify the tolerance expectations if needed within the contract documents prior to enforcing a specific plumb tolerance.
Section 12.3: Manhole Placement

- **12.3.4**: Install the conical top or flat slab top as shown on the approved shop drawing plumb and in alignment similar to the preceding barrel or base section.

- **12.3.6**: Place adjusting grade rings (if required) along with mastic sealant and frame with cover/grate to achieve specified finished grade.
Section 12.3: Manhole Placement

• 12.3.5: Adjacently placed manhole sections shall be aligned to match the step placement of the preceding section if steps are provided. Tolerance of step alignment shall be in accordance with Specification C478 (C478M). ASTM C478 states steps shall be aligned.

Note: C478, Section 16.5.5: The vertical spacing and vertical alignment between adjacent manhole steps and horizontal distance from the inside wall to the centerline of a manhole step may vary 1 inch from the design dimension.
Section 12.4: Joints and Joining

12.4.1: To ensure joint integrity when assembling the manhole structure, the installation contractor is responsible to maintain clean joint surfaces, removing all foreign materials that could damage or impair the jointing surfaces or gasket materials.

12.4.2: All joints shall be installed in accordance with the manhole manufacturer’s recommendations using only the materials supplied with the manhole structures.

12.4.3: Manhole joints that utilize resilient rubber gaskets shall be in accordance with Specification C443 (C443M).

12.4.4: Manhole joints that utilize mastic sealing material shall be in accordance with Specification C990 (C990M).
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ASTM Manhole Installation

Part 4 – Connecting Pipes to Manholes and Field Cutting or Coring
Section 12.6: Pipe-to-Manhole Connections

• 12.6.1: When resilient pipe-to-manhole connectors are furnished, they shall be furnished as follows unless prohibited by project specification:
  
  • 12.6.1.1: Sanitary Sewer, Water Reclamation or Reuse Applications – Specification C923 (C923M), Specification F2510/F2510M.
  
  • 12.6.1.2: Storm Sewer Applications – Specification C1478 (C1478M), Specification F2510/F2510M.
  
  • 12.6.1.3: Installation of the pipe utilizing the resilient pipe-to-manhole connectors is to be in accordance with the furnished manufacturer's recommendations. When completed, the pipe inverts shall meet the required elevations.
Two Primary Types of Pipe to Manhole Connectors

Boot Type

Compression Type
Compression Type Connector
Boot Type Connector
Section 12.6.3: Field Cut Pipe Openings

• NOTE 3 – Some manhole steel designs such as permissible hoop steel for 48 in. [1200 mm] diameter manholes do not permit pipe openings within the barrel sections. Unanticipated field cuts may require additional design analysis.

• 12.6.3.1: Any field cut of the manhole structure required for a pipe opening shall be approved by the engineer.
Section 12.6: Pipe-to-Manhole Connections

• **12.6.2:** If permitted by project specification or engineer, the installer may choose to use a cementitious non-shrink grouted pipe connection.

• **12.6.2.1:** Cast or cored openings of cementitious grouted connections shall not exceed pipe outside diameter plus 6 inches (150 mm), unless a larger opening is permitted by the engineer.

• **12.6.2.2:** Any pipe ends to be grouted into place shall have a water-stop assembly or material applied on the pipe end, which will be encased within the grouted connection.
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Section 12.5: Lift Hole Sealing

- **12.5.1:** Lifting holes (full penetration “see through”) shall be sealed by inserting into the hole a rubber or plastic plug, precast plug with mastic sealant or with an approved cementitious material (or filling the opening with non-shrink grout from inside, outside, or both).

- **12.5.2:** Lifting holes (full penetration “see through”) when employed as weep holes by design shall be sealed by securing outside placement of an approved non-woven geotextile fabric over the opening to eliminate soil migration but permit water flow.

- **12.5.3:** If required by project specifications. Embedded or cast-in lift anchors (“non-see through”) shall have the exposed small pocket volumes filled with non-shrink grout or with an impervious mastic material.
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ASTM Manhole Installation

Part 5 – Testing and Backfilling
• **13.1**: When required by the owner or designated by the project specification, the installer shall successfully test the completed manhole structure in accordance with the following methods:
  
  o **13.1.1**: Practice C969 (C969M)
  o **13.1.2**: Test Method C1244 (C1244M)
Section 13: Testing

ASTM C969 Hydrostatic Test
## ASTM C1244

### TABLE 1 Minimum Test Times for Various Manhole Diameters (20 - 120 in.) in Seconds

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Diameter, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Time, in seconds</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
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<tr>
<td>10</td>
<td>14</td>
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<td>15</td>
<td>20</td>
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<tr>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>

### TABLE 1 (continued) Minimum Test Times for Various Manhole Diameters (20 - 120 in.) in Seconds

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Diameter, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
<td>Time, in seconds</td>
</tr>
<tr>
<td>84</td>
<td>Time, in seconds</td>
</tr>
<tr>
<td>90</td>
<td>Time, in seconds</td>
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<tr>
<td>105</td>
<td>Time, in seconds</td>
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<tr>
<td>110</td>
<td>Time, in seconds</td>
</tr>
<tr>
<td>115</td>
<td>Time, in seconds</td>
</tr>
<tr>
<td>120</td>
<td>Time, in seconds</td>
</tr>
</tbody>
</table>

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![Image of testing equipment]
Testing an Installed Manhole Can Be Problematic
Testing an Installed Manhole Can Be Problematic
Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

Designation: C1244 – 05a–1

Vacuum Testing Precast Concrete Manholes

INTERSECTION RECORD

The intersection record is a critical part of the testing procedure. For each manhole, the record includes the following information:
- Manhole number
- Date of test
- Test results
- Any issues or observations during the test

WHEN TO PERFORM THE TEST!

The test should be performed prior to backfilling the manholes. This ensures that any potential issues with the manholes can be addressed before they become permanent. The test involves applying a vacuum to the manholes and monitoring the pressure drop over time. The test results are then analyzed to determine the manhole's integrity and performance.

For more information, visit www.precest.org
**Hydrostatic head above critical connector**

**At 22 feet below the groundwater table, the connector is naturally subjected to 9.5 psi**
• **12.7.2:** Excavations shall be backfilled with an approved or specified soil material free from large stones, rocks, pavement, and other items that could damage the installed manhole structure. Expansive soil material shall not be used as backfill around the structure.

• **12.7.3:** If required by site specifications, when a precast concrete manhole structure is placed in an unpaved area, slope the area around the entrance frame and cover to provide drainage away from the entrance cover. Slope the final grading upward to within 1 inch (25 mm) of the top surface of the frame and cover.
Section 12.7: Backfilling and Restoration

12.7.4 Backfill Procedures – Backfilling shall be achieved by using lifts (layers) and compactive effort or flooding (jetting) the excavation to meet the required soil density requirements. Backfill shall be placed around all sides of the installed section in lifts that shall provide adequate densification and not induce a lateral load shifting the manhole sections. If required by project specification, backfill lifts shall be placed uniformly around all sides of the installed section in lift thickness and with compaction to densities specified.
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ASTM C1821/C1821M

Section 12.7: Backfilling and Restoration

- **12.7.4.1**: The installer is to provide special care and placement of bedding and backfill material under and surrounding pipe connections to manholes to provide firm, uniform support of the pipe at these junctions. This compactive effort is to reduce the potential of pipe shear at the manhole interface due to differential settlement of the surrounding soil.
12.8: Restoration of the area where the circular manhole structure was installed shall meet the requirements of the project requirements or the engineer.

12.9: Follow-up inspections for settlement are required. Should settlement occur, the contractor shall be responsible for the necessary repair to restore the area to its original condition in accordance with the terms of the project requirements. If settlement is observed at the surface level, pipe connections should be inspected to ensure soundness.
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Precast Concrete Manhole Installation

Recommendations of ASTM C1821 and the NPCA

Copies of this standard can be ordered at:
https://www.astm.org/Standards/C1821.htm