NJWEA Excavation, Safety & Proper Pipe Installation, Winter 2024

Manufacturing/Testing of PVC Pipe

PRESENTED BY:
Chad Morrow

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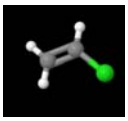
Manufacturing

PVC Resin

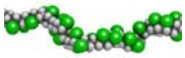
Chlorine

Ethylene



Vinyl Chloride

Polymerization Process



Polyvinyl Chloride

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Manufacturing

Ingredients

Ingredient	Purpose	Content Range (parts per hundred parts of resin)
PVC Resin	Primary structural component of PVC pipe	100
Heat Stabilizer	Protects against heat during manufacturing	0.3 to 1.0
Paraffin Wax	Lubricant during processing	0.6 to 1.5
Calcium Stearate	Lubricant and heat stabilizer	0.4 to 1.5
Titanium Dioxide	Provides UV protection	0.5 to 3.0
Calcium Carbonate	Modulus enhancer	0.0 to 5.0
Colorant	Identifying purpose of use for PVC pipe	Varies

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Manufacturing

Pipe Extrusion

PVC compound is fed into extruder → *Compound* is forced through die under high pressure (2000 psi to 5000 psi) → Pipe exits at roughly 400˚F and water cooled

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Manufacturing

Pipe Belling

One end of pipe is heated until pliable
End is placed over mandrel and expanded, forming bell
Gasket is integrally formed with the bell

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Testing

Dwell Test

Every piece of AWWA C900 pipe must be pressure tested to 2 x PC

DR	Pressure Class (psi)	Hydrostatic Pressure Test (psi)
25	165	330
21	200	400
18	235	470
14	305	610

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Testing

Sustained Pressure Test

ASTM D1598

- Sustained pressure test (2.1 x PC for 1,000 hour)
- Initial qualification and then requalification on regular interval

DR	Pressure Class (psi)	Sustained Pressure Test (psi)
25	165	350
21	200	420
18	235	500
14	305	650

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Testing

Burst Pressure Test

ASTM D1599

- Burst pressure test (3.2 x PC for 60-70 seconds)
- Initial testing and then lot testing (can substitute with ring-tensile testing)

DR	Pressure Class (psi)	Burst Pressure Test (psi)
25	165	535
21	200	630
18	235	755
14	305	985

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Testing

Joint Test (Pressure)

ASTM D3139

- Vacuum pressure test (-10.8 psi (22 in. Hg) for 1 hour)
- Sustained pressure test (2.5 x PC for 1 hour)
- Burst pressure test (3.2 x PC for 60-70 seconds)
- Joint at maximum offset and flattened 5%

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Testing

Joint Test (Sewer)

ASTM D3212

- Internal pressure test (25 feet of head (10.8 psi) for one hour)
- Internal vacuum test (-10.8 psi (22 in. of Hg) for 1 hour)
- Test at maximum offset and flattened 5%

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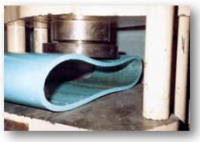
Testing

Flattening Test

ASTM D2412

- Loading applied in 2 – 5 minutes
- 30% deflection before reverse curvature (Installed deflection ≤ 7.5% → SF = 4.0)
- 60% deflection without splitting, cracking, or breaking
- Lot testing



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Testing

Stiffness Test

- Pipe Stiffness is measured by deflecting pipe to 5% deflection, and recording load
- $PS = \frac{F}{\Delta y}$
- Pipe must meet minimum pipe stiffness required for a DR/wall thickness (46 psi, 75 psi or 115 psi)

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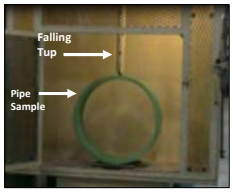
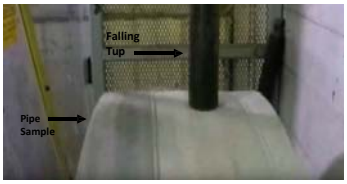
Testing

Impact Test

Meets requirements of ASTM D2444

Pipe must withstand minimum 220 ft-lb impact strength





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Testing

Extrusion Quality Test

ASTM D2152

- Samples immersed in acetone solution for 20 minutes
- Must not have lifting, raising, or removing of any material
- Lot testing

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Testing

Other Testing

Components of PVC pipe must also be tested

Fittings, couplings require pressure testing

Fused joints require pressure and tensile testing

PVC pipe for potable water applications must be NSF 61 certified

Additional requirements for FM or UL certifications

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Questions?

Thank You

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NJWEA Excavation, Safety & Proper Pipe Installation, Winter 2024

Installation and Tapping of PVC Pipe

PRESENTED BY:
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PVCPIPE association

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Agenda

- Typical Installation
- Tapping
- Sewer Laterals
- Special Installation Considerations
- Questions

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Typical Installation

Handling and Storage

- When unloading, care should be given so that forklifts do not damage pipe
- Avoid severe impact blows and abrasion damage
- Use straps instead of chains for lifting
- Unload and store pipe bundles as they were shipped
- Ensure stored pipe is resting on dunnage, not other pipe
- Pipe should be stacked no more than 8ft high
- Any pipe with problems should be noted and set aside and the supplier contacted

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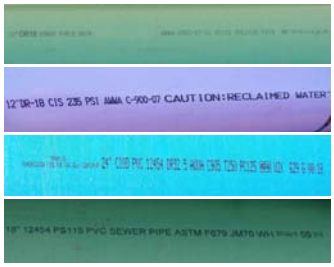
Typical Installation

Print Line

- Size
- OD Type
- Manufacturer
- Standard
- Class/Type
- Certifications
- Date Code
- Allowable Pull



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Typical Installation

Pipe Assembly

- Provide a worker at both ends
- Clean the spigot and bell
- Position in straight alignment

- Lube per instructions
- Insert spigot into bell
- Push together to insertion line
- DO NOT OVER-INSERT PIPE
- Insertion line(s) must be visible

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Typical Installation

Pipe Assembly

← Bar-and-Block

Mechanical Puller →

← Hydraulic Puller

Excavator/Backhoe →

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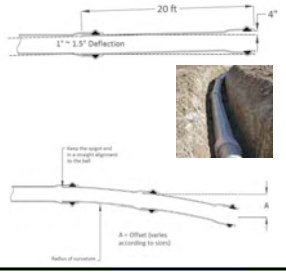
Typical Installation

Changes in Direction



Joint Deflection
- 1 to 1.5° Joint Pull Typically Available

Fabricated Fitting
- Available in 1-5° Sweeps or Angled Couplings
- Fittings for angles over 5° (5.625°, 11.25°, 22.5°, 45°, 90°)

Longitudinal Bending
- Within limits of *Contractor's Guide for Installation of Gasketed PVC Pipe*

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Typical Installation

Bedding and Backfill

Ensure proper placement and compaction of haunching materials

Eliminate voids in haunching area/under the pipe

Can use native or imported backfill materials



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Typical Installation

Pressure Fittings

AWWA C900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1500 mm)

AWWA C907 Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In. (100 mm Through 300 mm)

Since PVC is Manufactured to CIOD, Ductile Iron Fittings Can Also Be Used



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Typical Installation

Acceptance Testing

Pressure: Hydrostatic Test
- Backfilled Enough to Prevent Movement (1.5 Pipe Diameters)
- Max Pressure of 1.5 x Operating Pressure
- NEVER use High-Pressure Air for Testing Pressure Pipe

Gravity Sewer: Deflection Test (Mandrel Test)
- 92.5% of base ID for 7.5% deflection limit *or* 95% of base ID for 5% deflection limit
- Testing recommended after 30 days to allow for consolidation
- Measure of installation quality, not pipe quality

Gravity Sewer: Low-Pressure Air Test
- Follow Uni-Bell UNI-B-6 and ASTM F1417 recommendations
- Do not exceed 9 psi
- All plugs need to be braced for pressure
- Large diameter pipe joints may be air tested individually

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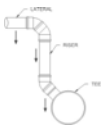
Typical Installation

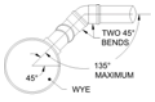
Sewer Laterals

Position connection in a straight alignment

Do not bend or deflect laterals

Lateral may be different OD type than main line





Lateral connection

Transitions should be smooth and supported

Lateral an angles cannot be greater than 45°

All laterals and mains will be properly supported

Proper compaction is required

All cuts will be clean and square

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Tapping

Direct taps – the branch line is connected to the main by a corporation stop that is screwed directly into the pipe wall. Maximum branch line size is 1 inch.

Saddle taps – the branch line is connected to a main by a corporation stop that is screwed into a metal saddle that wraps around the pipe. Maximum branch line size is 2 inch.

Sleeve taps – the branch line is joined to the main via a connection at a metal sleeve that wraps around the pipe. Maximum branch size is the same as the main.

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Tapping

Availability

TAPPING: AWWA PIPE

Pipe Material	Pipe Standard	Size (in.)	DR	TAPPING TYPE		
				Direct Tap	Saddle Tap	Sleeve Tap
PVC	C900	4	All	Not Recommended	≤ 2" diameter	Up to size-on-size
		6	25	Not Recommended	≤ 2" diameter	Up to size-on-size
		6	18	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		6	14	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		8	25	Not recommended	≤ 2" diameter	Up to size-on-size
		8	18	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		8	14	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		10	All	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		12	All	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		14	≥ 41	Not recommended	≤ 2" diameter	Up to size-on-size
		14	≤ 32.5	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		16	≥ 51	Not recommended	≤ 2" diameter	Up to size-on-size
		16	≤ 41	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		≥ 18	All	Not recommended	≤ 2" diameter	Up to size-on-size
PVCO	C909	All	All	Not recommended	≤ 2" diameter	Up to size-on-size

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Tapping

Coupons

Coupon with Striations

Coupons Showing "Crown" at Outer Surface

Coupons Showing "Punch-Through" at Inner Wall

Striations

- Indicate a Dull Cutter, Too Rapid Feed Rate, or Lack of Lubrication on Cutting Tool

Crown

- Indicates Feed Rate was Excessive

Punch-Through

- Excessive Feed Rate, Dull Cutter, or Cutter is of Insufficient Depth for the Pipe Wall Thickness

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Tapping

Availability

TAPPING: ASTM PIPE

Pipe Material	Pipe Standard	Size (in.)	DR	TAPPING TYPE		
				Direct Tap	Saddle Tap	Sleeve Tap
PVC	D2241	4	All	Not recommended	≤ 2" diameter	Up to size-on-size
		6	≥ 21	Not recommended	≤ 2" diameter	Up to size-on-size
		6	≤ 17	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		8	≥ 26	Not recommended	≤ 2" diameter	Up to size-on-size
		8	≤ 21	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		10	≥ 32.5	Not recommended	≤ 2" diameter	Up to size-on-size
		10	≤ 26	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		12	≤ 41	Not recommended	≤ 2" diameter	Up to size-on-size
		12	≤ 32.5	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		14	≥ 41	Not recommended	≤ 2" diameter	Up to size-on-size
		14	≤ 32.5	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		16	≥ 51	Not recommended	≤ 2" diameter	Up to size-on-size
		16	≤ 41	≤ 1" diameter	≤ 2" diameter	Up to size-on-size
		≥ 18	All	Generally not allowed	≤ 2" diameter	Up to size-on-size
PVCO	F1483	All	All	Not recommended	≤ 2" diameter	Up to size-on-size

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Tapping

Coupons

- Coupon: Cylindrical Piece of PVC Wall Removed During Tapping
- Coupon Should Be Examined after Removal from the Cutter Head
- Smooth Coupon Indicates Feed Rate was Correct and Cutter was Functioning Properly

Smooth Coupons

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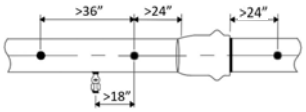
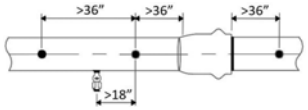
Tapping

Spacing



12" and Smaller

14" and Larger



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Special Installation Considerations

UV Exposure

- PVC pipe is gray or white without colorants
- Colorants NOT meant to be color-fast; for identification ONLY
- Fading is expected when exposed to Sun
- Fading does NOT equal degradation
- Fading occurs only in top 0.002" of pipe wall
- Light-colored or white-colored pipe is okay
- Brown/yellow/black-colored pipe signifies longer-term issues
- Any light-colored opaque cover will prevent sun fading

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Special Installation Considerations

Locating PVC Pipe


Tracer Wire


Metallic Tape


Radio Wave


Ground-Penetrating Radar

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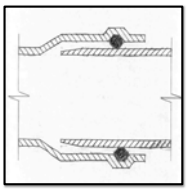
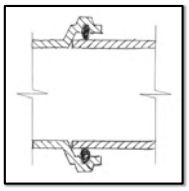
Special Installation Considerations

Ductile Iron Connections


Deep PVC Pipe Bell


Shallow M.J. Fitting Bell

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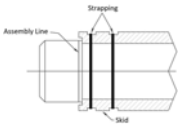
Special Installation Considerations

Pipe in Casing

PVC pipe can be installed with tunnel skids or casing spacers

Skids or spacers should be aligned with insertion line to prevent over-insertion



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Special Installation Considerations

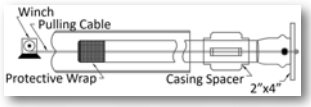
Pipe in Casing

Pipe can be pushed or pulled through a casing

Pulling or pushing pipe causes the same forces on the joints

Good practice is to wrap the spigot end to protect against any abrasion

Concerns about heat of hydration can be mitigated by filling pipe with water during grouting



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Special Installation Considerations

Pipe Repairs

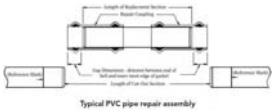
Pipe with gouges or scratches should be addressed in accordance with AWWA C605

Repairs can be made with clamps or with a replacement section and couplings

Repair clamps are utilized for localized damage; replacement sections are utilized for damaged areas that extend beyond a localized area

If one end of the existing pipe is a bell-end, only one repair coupling is required.

Replacement repair procedure for PVC pipe is outlined in *Contractor's Guide*


Typical PVC pipe repair assembly

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Thank You

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