

PVC VS. FIBERGLASS (FRP) MUNICIPAL PRESSURE PIPE: ADVANTAGE PVC

In North American municipal markets, PVC pressure pipe has been in widespread use for more than 60 years, at first in smaller diameters but now in sizes up to 60-inch. Fiberglass (FRP) pressure pipe has been on the market for a similar period, primarily in diameters of 24 inches and larger.

Standards

PVC and FRP pressure pipes are manufactured per current AWWA standards as follows:

- PVC – AWWA C900 “Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1500mm)”
- FRP – AWWA C950 “Fiberglass Pressure Pipe”

PVC pipe installation must meet the requirements of AWWA C605 “Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pipe and Fittings.” There is no AWWA installation standard for FRP pipe.

Wall Construction

PVC pipe is homogeneous, meaning that the same material is used throughout the pipe wall thickness. In contrast, FRP is a composite material consisting of multiple layers that may include a surface layer on the outside, a liner on the inside, and middle layers that are composed of resin, fillers, and fibers.

Wall Thickness

For both materials, wall thicknesses are a function of long-term hydrostatic strength. PVC pipe’s minimum wall thickness must be 100% of the calculated wall thickness, but FRP is allowed to thin its minimum wall to 87.5% of the calculated value.

Outside-Diameter Measurements

PVC pipe must meet outside diameter (OD) requirements throughout its length, so a cut-off pipe will still have proper dimensional tolerances for sealing at a gasketed joint. This is not always true for FRP pipe – AWWA C950, Tables 3 to 6 include a note that states: “Some pipes are manufactured such that the entire pipe meets the OD tolerances, while other pipes meet the tolerances at the spigots — in which case, if such pipes are cut (shortened), the ends may need to be calibrated to meet the tolerances.” This variation in ODs requires extra steps by the installer to ensure compatibility of fittings and that joints can be watertight. Non-standard ODs may also result in utilities experiencing problems during maintenance and repair.

Ring-Deflection Testing (Flattening)

AWWA C950 requires fiberglass pipe to be deflected between 9% and 18% (depending on stiffness class) without cracking or crazing. AWWA C900 requires all PVC pipe to be deflected 60% without damage – a much more rigorous test.

Pipe Stiffness (PS) and Deflection

Both PVC and FRP are considered flexible pipes and use the same test to determine pipe stiffness (PS): ASTM D2412 “Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.” However, there is a large difference in PS values for both materials which is important when considering overall deflection during design and installation. Section 4.7 of AWWA C950 lists the upper limit for FRP pipe’s “Stiffness Class” as 72 psi. In contrast, AWWA C900 has an upper PS limit of 815 psi for PVC pipe. This means that PVC has a lower deflection under the same load. As well, PVC has a higher limit of deflection at 7.5% compared to 5% for FRP.

Pipe Longevity

According to several studies, PVC pressure pipe longevity is 100+ years. For FRP the picture is not clear: widespread failures in the 1980s required a significant change to product standards and manufacturing methods. Those changes occurred in the mid-90s, so the in-service history of the newer products is limited to about 20 years.

PVC VS. FIBERGLASS (FRP) MUNICIPAL PRESSURE PIPE: ADVANTAGE PVC

For Large-Diameter Pressure Pipe Applications, PVC Is the Product of Choice

In summary, PVC pressure pipe has several advantages over FRP:

- PVC is more forgiving regarding pipe deflections
- PVC pipe is subjected to more rigorous product testing
- PVC has tighter dimensional controls that reduce potential problems during installation and operations
- PVC has a design life in excess of 100 years

Utilities looking for large-diameter piping have proven options available from the PVC pipe industry. As municipalities and engineers attempt to reduce costs and improve system performance, consideration should be given to some of the significant differences between PVC and FRP pipe.

The table below summarizes some of the important differences between the two materials:

PVC versus Fiberglass Pressure Pipes		
Property	PVC	Fiberglass (FRP)
Life Expectancy	100 years +	Not enough history to determine
Durability	Not susceptible to degradation	Susceptible to degradation if lining is compromised
Pipe Wall Construction	Homogeneous (one material)	Composite (layers of several materials)
Pipe Wall Minimum Thickness	100% of nominal thickness	87.5% of nominal thickness
Hydraulics	Hazen-Williams C=150	Hazen-Williams C=150
Fittings	At 80°F and higher	At 90°F and higher
Pipe Stiffness - Upper Limits	Up to 815 psi	Up to 72 psi
Maximum Allowable Long-Term Deflection	7.5%	5.0%
Sustained-Pressure Test	2.1 times PC for 1,000 hours	No test
Flattening Test	Deflected 60% without damage (all sizes)	Deflected 9% to 18% without damage (depending on size)
Joint Test Assembly #1	Pipe deflected axially in joint	Pipe deflected axially in joint
Pressure	ASTM D3139 Low: 0.5 times PC for 60 min High: 2.5 times PC for 60 min, then increase to 3.2 times PC	ASTM D4161 Low: no test High: 2.0 times PC for 10 min
	Vacuum	10.8 psi for 60 min with no loss
Joint Test Assembly #2	No additional tests required	Shear-load pressure test required

References: ASTM D2412; AWWA C605; AWWA C900; AWWA C950; AWWA Manual M23; AWWA Manual M45; "Fiberglass Pipe Literature Review," Bureau of Reclamation (2016); Handbook of PVC Pipe, Uni-Bell PVC Pipe Association (2013); "PVC Pipe Longevity Report," S. Folkman (2014)