

PVC VS. FIBERGLASS (FRP) GRAVITY SEWER: ADVANTAGE PVC

There are common misconceptions among design engineers regarding pipe stiffness, pipe deflection, impact strength, abrasion, and design life when comparing PVC and fiberglass (FRP) sewer pipes. When correct evaluations are done, PVC is the product of choice.

Standards

PVC sewer pipe has been used for more than 60 years, at first in smaller diameters but now in sizes up to 60-inch. FRP sewer pipe has been available for a shorter time period, primarily in diameters of 24 inches and larger.

FRP and PVC large-diameter sewer pipes are manufactured per current ASTM standards as follows:

- FRP – ASTM D3262 “Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe”
- PVC – ASTM F679 “Standard Specification for Polyvinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings”

Pipe Stiffness (PS): No Need to Specify Higher PS for PVC

A common misunderstanding is that PVC pipe must be specified with a higher PS to be equal to FRP pipe. Both PVC and FRP employ the same test to determine PS: ASTM D2412 “Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.” Also, both standards include the most common PS of 46 psi and a less flexible product with PS of 72 to 75 psi. The F679 standard for PVC also provides an even stiffer value with PS of 115 psi. Since PS values are equivalent, the deflection calculations should provide the same percentage deflection no matter which pipe is used.

In flexible pipe design, the pipe embedment quality usually has a greater influence on limiting pipe deflection than does the pipe stiffness. However, fiberglass is more sensitive to embedment quality since it has less flexibility and it is subject to strain corrosion.

In summary, both standards include stiffness-equivalent pipes at PS = 46 psi and PS = 72 to 75 psi; PVC includes a third product line that is much stiffer at PS = 115 psi. FRP is able to produce products with higher than 72 psi stiffness, but this requires a reduction in allowable pipe deflection.

Pipe Deflection – FRP Subject to Damage at Lower Deflection Levels

Both FRP and PVC pipes are considered flexible pipes and use the same analysis method – the Modified Iowa Equation. This means that the same pipe deflection occurs for both products for the same loading and the same PS. However, FRP has much tighter limits on how much deflection is allowed:

- FRP: 4% (short-term); 5% (long-term)
- PVC: 7½% (short- and long-term)

Because of its greater allowable deflection, PVC pipe can be buried to greater depths. Expressed another way, the same deflection occurs for both pipes, but FRP is subject to damage at lower deflection levels. The FRP standard, ASTM D3262, requires that strain corrosion be considered, which can limit the maximum deflection of FRP pipe to 4% when the pipe is designed for a 50-year life. Also, FRP pipes are frequently specified with vinyl ester interior lining limiting the maximum long-term deflection to 4% and short-term deflection to 3%.

Impact Strength – Construction Impacts Can Lead to Failure of Installed FRP

ASTM F679 requires that PVC gravity sewer pipe be tested for impact resistance in accordance with ASTM D2444 “Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).” FRP has no such test requirement, which is surprising since FRP’s inside-diameter liner can crack when subjected to impact forces. Cracking of the interior liner of FRP pipe can cause premature failure of the pipe due to strain corrosion.

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Abrasion Resistance – FRP Averages Greater Abrasion Wear

Based on abrasion testing of different pipe materials by the Institute for Hydromechanic and Hydraulic Structures of the Technical University of Darmstadt (TUD), Germany, PVC pipe had about three to four times the resistance to abrasion as FRP pipe. TUD’s test has now become a standard test method for abrasion testing for pipes.

Design Life – FRP Subject to Strain Corrosion

PVC sewer pipe does not deteriorate in service – its design life is 100+ years. In fact, a recent Australian study showed the residual expected life of installed PVC sewer pipe to be as much as 288 years. To read the paper, [click here](#).

In contrast, FRP is subject to strain corrosion. FRP’s interior layers are subject to corrosion if cracks occur on the inside or outside layers. These cracks can occur if the pipe experiences too much deflection. According to their industry publications and ASTM D3262, FRP’s design life is only 50 years at its maximum deflection levels.

One reason for PVC pipe’s long life is that it is a homogeneous material, meaning that the same material is used throughout the pipe wall. In contrast, FRP is a composite material consisting of multiple layers of fillers, resin, and fibers that vary in their ability to resist corrosion.

Advantage PVC Sewer Pipe

As shown above, when comparing fiberglass and PVC sewer pipes, PVC is the clear winner since it:

- Provides more pipe-stiffness options
- Is more forgiving regarding pipe deflections
- Has significantly greater impact resistance
- Has about four times the resistance to abrasion
- Has a longer design life

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

Utilities looking for large-diameter piping for their sewer networks 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 sewer pipe materials. The table below summarizes some of the key differences between the two materials.

PVC versus Fiberglass Gravity Pipes		
Property	PVC	Fiberglass
Design Life	100 years	50 years
Longevity for Sewer Service	100 – 250+ years	50 years
Maximum Long-Term Deflection Limit	7.5%	5.0% (4 % with vinyl ester)
Maximum Short-Term Deflection Limit	7.5%	4.0% (3 % with vinyl ester)
Maximum Deflection w/o Damage	60% (for all pipe stiffnesses)	9% - 12% (based on max. pipe stiffness of 72 psi)
Corrosion Resistance to Sewer Effluent	Complete	Subject to corrosion failure if inner lining cracks
Abrasion Wear	0.37 – 0.58 mm of wear per 400,000 cycles	1.08 – 2.42 mm of wear per 400,000 cycles
Strain Corrosion	None	Susceptible
Maximum Pipe Stiffness per Standards	115 psi	72 psi
Pipe Pushing	With restrained joints	With special joints
Pipe Pulling	With restrained joints	Not available
Test for Minimum Impact	Yes	None

References: ASTM D2412; ASTM D2444; ASTM D3262; ASTM F679; *Handbook of PVC Pipe*, Uni-Bell PVC Pipe Association; “Wear Data of Different Pipe Materials of Sewer Pipelines,” University of Darmstadt; Whittle and Tennakoon, “Predicting the Residual Life of PVC Sewer Pipes;” “The Complete Hobas Guide,” Hobas Pipe USA