Value Engineering Commercial DWV with Foam Core PVC

While the plumbing industry still debates cast-iron soil pipe or PVC, a new, even lower-cost alternative is being introduced on many commercial projects.

BY PAUL TULLY

Until the 1960s, mechanical engineers and plumbing designers specified hub and spigot cast-iron soil pipe joined with lead and oakum for drain, waste and vent systems in the vast majority of their commercial projects.

With the introduction of the CISPI 301 standard, hubless cast-iron soil pipe offered material and labor savings to plumbing contractors while still providing a durable, reliable system. PVC piping systems, first installed in Germany in 1934, began appearing in multistory buildings in the late-1960s and 1970s here in the US. However, PVC piping systems were primarily used in single-family and some multifamily applications during that time. Then, beginning with the Great Recession in 2008, many commercial contractors offered PVC as a value-engineered alternative to project owners to lower construction costs.

Today, while the plumbing industry still debates whether to use cast-iron soil pipe or PVC on a particular project, a new, even lower-cost alternative is being introduced on many commercial projects—cellular core PVC.

Within 60 years, a relatively short period in the history of plumbing, commercial DWV systems have been value engineered from hub and spigot cast-iron soil pipe to foam core PVC. Is the latest proposed alternative the right choice for commercial plumbing?

Cellular core PVC

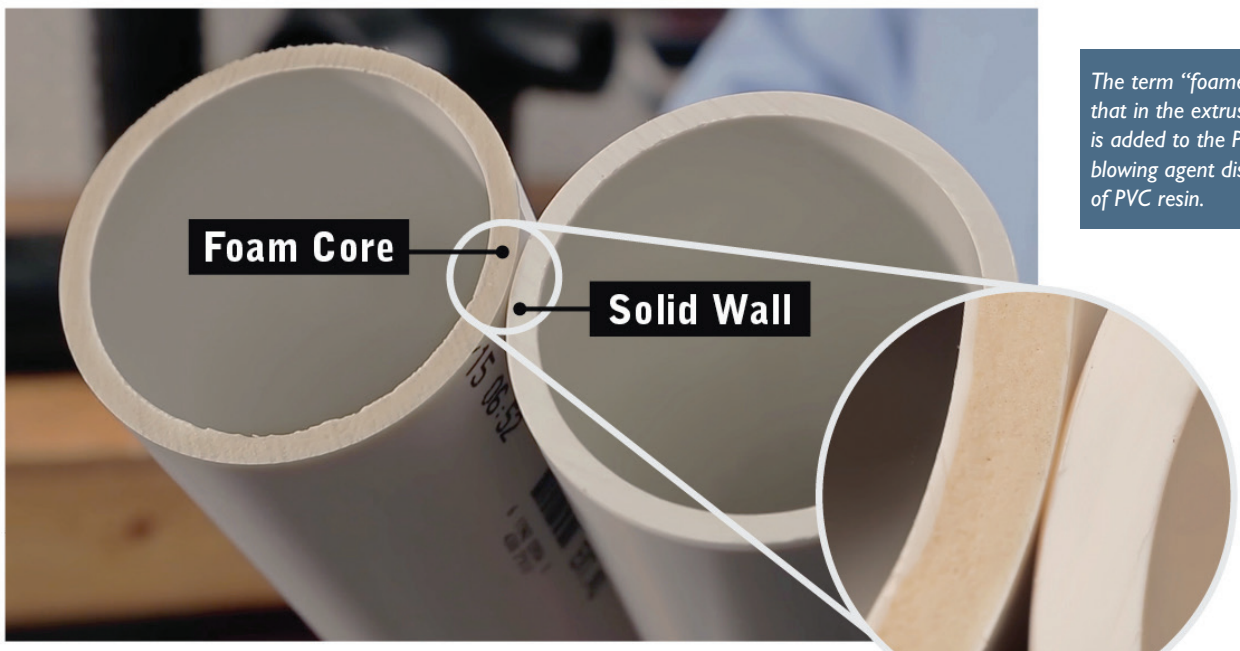
Schedule 40 PVC cellular core pipe, commonly referred to as foam core pipe, is manufactured to ASTM F891, *Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core*. This specification covers coextruded PVC plastic pipe with a cellular core and concentric inner and outer solid layers and is produced using a multilayer coextrusion die.

Product manufactured to this standard consists of a foamed PVC core and two thin skins of solid PVC. The term "foamed core" refers to the fact that in the extrusion process, a blowing agent is added to the PVC in the center layer. This blowing agent displaces a significant amount of PVC resin.

In essence, cellular core pipe has less PVC than solid wall PVC pipe. Cellular core PVC pipe is listed for gravity systems only and not rated for pressure. The print line on the pipe generally includes terms such as "COEX," "CELLULAR CORE" and "NOT FOR PRESSURE."

Cellular core pipe technology was developed in France in 1979 by Alphacan, a large, multinational pipe company. Alphacan introduced cellular core pipe into the French market in 1982, and the product quickly gained acceptance and market share.

The manufacturing process resulted in a pipe that was less expensive, lighter in weight and easier to cut. By the late-1980s, cellular core PVC pipe was produced regionally in parts of the United States by various pipe manufacturers, and it attained



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Pipe Size	PIPE STIFFNESS VALUES (lbf/in² @ 73°F †) PVC Sch 40 F891 (Foam Core)	PVC Sch 40 D1785/ D2665 (Solid wall)
2"	300	600
3"	300	510
4"	200	310
6"	120	150
8"	100	100
10"	60	78
12"	50	63
14"	—	59
16"	—	59

significant market share in single-family residential construction.

It is interesting to note that many plumbing professionals commonly refer to solid wall PVC pipe as "Schedule 40" and cellular core pipe as "foam core," conflating the topics.

For an engineer reviewing submittals, it is important to remember that both solid wall and foam core are manufactured to Schedule 40 dimensions. Schedule 40 refers only to the dimensions of the pipe (O. D., wall thickness, etc.) and has nothing to do with the material composition of the pipe. If an engineer scans the piping submittals and sees "Sch 40," he may think he is getting solid wall PVC pipe. Submittals for solid wall PVC pipe will contain references to ASTM D2665 and ASTM D1785.

Code compliance

The ASTM F891 manufacturing standard is referenced in all major model plumbing codes. As with any code item, always check with the authority having jurisdiction for acceptability, limitations or restrictions. In some local jurisdictions, cellular core pipe is not permitted in commercial construction.

It is important to remember that code compliance is the minimum requirement for performance of any given material. Just because a product meets the code does not mean that the material is optimal, or even viable, for a particular project.

So, how does cellular core PVC pipe compare with solid wall PVC pipe? Engineers, designers, specifiers, contractors, building owners and facility managers should evaluate the performance capabilities of all materials based on the requirements of the specific project over the life of the structure.

Here are several points to consider:

Strength: In buried applications, a commonly asked question is "What is the crush strength of PVC pipe?" The questioner often wants a simple answer in tabular format and is sometimes frustrated with the complexity of the answer.

As flexible systems, both cellular core and solid wall PVC piping systems work with the surrounding soil to support an earth or live load, termed the "soil-pipe mechanism." For that reason, the crush strength of a section of PVC pipe in a press without the support provided by the surrounding soil is not relevant.

The Iowa Formula is commonly used for this purpose. The Uni-Bell PVC Pipe Association publishes a very helpful calculator based on the Iowa Formula that is available as a free download from its website (uni-bell.org). Uni-Bell's Handbook of PVC Pipe is an excellent and inexpensive reference that aids in the use of the calculator.

The Uni-Bell calculator allows a designer to input variables specific to the application, including maximum allowable deflection, soil modulus, load parameters, additional live loads, pipe diameter and pipe stiffness. Pipe stiffness values for these equations can be taken from the applicable ASTM standards and are available from pipe manufacturers.

The table on this page lists the pipe stiffness values from the ASTM F891 and ASTM D2665 standards. The pipe stiffness values differ for foam-core PVC and solid-wall PVC pipe for smaller diameters, eventually merge at 8-inch diameters, but diverge again at diameters of 10 inches and 12 inches. When these values are entered into the Iowa Formula, the results demonstrate a greater load capability for solid wall PVC pipe than form core.

Sound attenuation: Many consider foam core PVC pipe to be the "loudest" DWV pipe. Sound attenuation is a function of material density. The more dense the piping material, the better sound attenuation it provides.

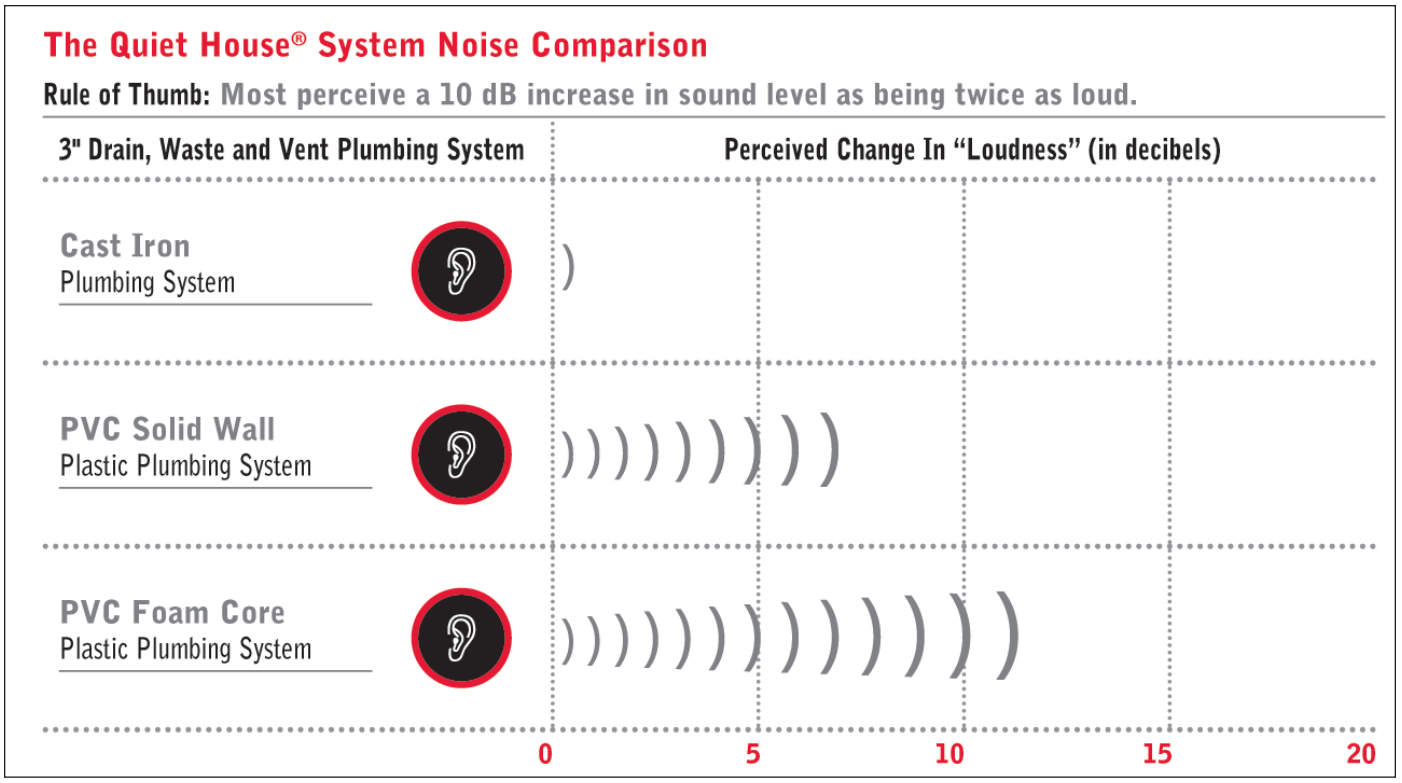
The chart on the next page shows the perceived "loudness" provided by the three most common types of DWV piping systems.

While advocates of foam core PVC pipe contend that the market offers numerous products that can be used for sound abatement on these systems, many times the addition of sound-attenuation materials can negate the cost savings that foam core PVC pipe offers.

Keeping in mind that a contractor's biggest cost factor is labor, does it make financial sense to go back a second time and install more material on the same system? For facilities and structures that require minimal ambient noise levels, such as schools, hospitals, upper-end residential and condominiums, foam core pipe will probably not be the optimal material choice.

Temperature capabilities: Cellular core PVC pipe is manufactured from the same PVC compound as solid wall PVC pipe. It, therefore, has the same temperature capabilities as solid wall PVC. Both PVC products have a maximum operating temperature of 140 degrees.

Installation: Both cellular core and solid wall PVC pipe are joined using a two-step solvent welding process



consisting of primer conforming to ASTM F656 and cements conforming to ASTM D2564. Cement manufacturers make no distinction between these two different piping systems in regard to cutting, preparation, joining, cure times and set times.

In above-ground installations, cellular core PVC has the same requirements for horizontal and vertical support. Additionally, both are combustible per ASTM E136 and, therefore, cannot be installed in a return air plenum without additional fire wrap.

Below ground, there is a major installation requirement difference. While both products are suitable for burial, as mentioned earlier, solid wall pipe is somewhat more robust and stiffer, particularly in sizes 6 inches and smaller. However, ASTM F891, Appendix X3, Installation, paragraph X3.1, has the following limitation: Maximum aggregate size shall be limited to ½ inches (13 mm) for angular and ¾ inches (19 mm) for rounded particles.

This statement is significant, as ASTM D2321, *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*, allows aggregate and stone that pass through a 1½-inch sieve. In other words, foam core PVC pipe takes even more care than solid wall PVC pipe to be installed below ground.

Mechanical maintenance: In facilities that require regular or frequent cleaning, the use of mechanical devices such as auger bits or snakeheads is commonplace, and special consideration should be used when selecting what material can or should be specified.

Repeated passes with a mechanical cleaning device can eventually nick, chip or wear down the thin inner wall to the point where the cellular core is exposed to the effluent being conveyed. While there is no definitive study that determines how many passes with a mechanical device will lead to pipe degradation, many specifiers will avoid the issue altogether and require solid wall PVC.

Jobsite damage: Because cellular core pipe consists of two thin skins, it is more susceptible to job site damage. Damage to the surface of cellular core pipe could lead to increased leaks in the pipe itself or an issue known as "weeping" should the pipe have to endure sustained static head pressure in the event of a blockage during operation of the system.

Cellular core PVC does offer advantages, primarily lower cost, lighter weight and easier cutting. However, these advantages must be evaluated against the loss of strength and sound attenuation, additional care required in underground installations, and additional maintenance considerations that are inherent with cellular core products. ●

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Decision Criteria Checklist

- To determine whether cellular core PVC is acceptable or appropriate for a given commercial project, evaluate these decision criteria:
- Does the AHJ allow cellular core piping in commercial construction?
- What are the burial conditions?
- What are the backfill materials?
- Is sound attenuation important to the successful use of the facility?
- Will the lower price of using cellular core PVC outweigh the additional cost of adding higher-performing sound-abatement materials?
- Will the facility require regular or frequent cleaning using mechanical devices?
- Will the savings generated by using cellular core PVC outweigh any potential future issues?