A Glance at Plastic Pipe from All Angles

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Abstract

Plastic pipe is a commodity with an immense amount of variety and possible applications. When exploring its benefits in a modern infrastructure there are countless professions involved, with varying degrees of relevance. Each has a unique perspective of plastic pipe. I intend to analyze all possible perspective lenses, from owners’ representative to geotechnical engineer to the utilities subcontractor and beyond, in order to uncover the true, most useful, and most relevant benefits that plastic pipe has to offer in a modern infrastructure. Before doing so, evaluating proven scientific facts about different types of plastic pipe and addressing any applicable criticisms as well as their validity would foster our research. Doing so will allow us to intelligently compare plastic pipe to its alternatives and draw our own conclusions. Despite the fact that most of the literature available on the subject is biased and therefore unreliable, this paper attempts to filter through the propaganda and uncover the truth.

In today’s society, a properly planned infrastructure is crucial to the development and success of every municipal area. Careful consideration must take place for each minute detail from direction to slope to flow volume. If designed correctly, a water infrastructure will work efficiently with minimal maintenance and maximum service life while also providing a convenient way for new projects and extensions to tie in with ease. Pipe material to be used is the first and easily one of the most important decisions to be made in a project. Cost, sustainability, constructability, maintenance, durability, and service life comprise a short list of the countless factors that should be taken into account regarding material selection since it has the potential to affect thousands of people for years to come. Whoever is tasked with making this decision must be able to take an objective approach, comparing and contrasting all possibilities. In order to do so they must examine the scientific, irrefutable facts available while considering all perspective lenses involved and analyzing any counterarguments as well as their validity. Only then can a person truly understand the comparisons between materials available in the piping industry. The following paper uses this exact approach to determine the benefits of using plastic pipe in a modern infrastructure.

The term plastic pipe is very generic and slightly misleading since it encompasses a very broad range of products that can be used in virtually every sector of infrastructure. This includes fire lines, gas lines, sanitary and storm sewers, irrigation, electrical conduits, and indoor plumbing just to name the most prevalent. Plastic pipe is currently widely accepted by building codes throughout North America for above grade, below grade, pressure, and non-pressure applications. It can be manufactured in a variety of colors which are usually indicative of intended application and subsequently a special composition which caters to its intended use. All types have an appreciably smaller environmental impact during manufacture than all other

pipe materials for reasons which we will go further into detail later. One of the most impressive stats about plastic piping is the vast range of products available on the market when all of the many sizes, special compositions, jointing options, fittings, valves, ducts, pumps, and tanks are factored into the equation.

Some of the most common types of plastic pipe in the industry today are polyvinyl chloride (PVC), high-density polyethylene (HDPE), and cross-linked polyethylene (PEX), all of which can be further broken down into sub-groups. For simplicity, this paper will limit its discussion to the general categories mentioned above rather than going into detail about each and every type of plastic pipe there is to offer.

PVC has been extensively used in the United States for the past 20-30 years, the longest out of any plastic pipe variety. It is the most common, versatile, and well-known type partly because it is used by countless other industries. Many people would be surprised to hear that “PVC comprises raw materials sourced from approximately 44% fossil hydrocarbons (oil, natural gas or coal) and 56% salt. At the end of their life PVC and HDPE pipes can be collected, recycled and used into other products” (Osry), an attribute that contributes to the materials’ relatively low environmental impact. According to The Vinyl Institute, “Today’s vinyl production is essentially closed, automated and high tech, and nearly all waste is recycled back into the system” (Gibson).

HDPE, sometimes just called PE, is a flexible thermoplastic material that can be manufactured in coils or in straight lengths. It performs especially well at low temperatures in comparison to other materials which are more likely to succumb to brittle failure, making it ideal for certain unique applications. PEX is composed of the same material as HDPE but is modified

for increased capabilities. Most notably, similar to HDPE’s superiority in cold situations, PEX is better suited for high temperature applications such as fire sprinkler systems and radiant floor heating. (PPFA)

Plastic pipes’ biggest claim to fame is superior durability. Its unique chemical composition paired with a laminar molecular structure gives it the capability of resisting structural failure far better than other materials. It is this durability and plastic’s resistance to corrosion that results in an extended service life which is currently predicted to be 50 to 100 years. (McCraven).

No matter what the project may be, chances are there is a piece of plastic pipe available that can get the job done. The construction industry is composed of a very complex process in which many people play a role. Each project, no matter how large, requires extensive collaboration between all parties involved, and the process moves a lot more efficiently when everyone can reach an agreement. Sadly, situations where all members agree on one method, design, or material to be used are few and far between. Given the fact that each of these people most likely possesses a unique knowledge base, skill set, and agenda with respect to the job, it would be useful to take each specific viewpoint into account when considering the benefits a particular material can impart on the industry. I intend to analyze all possible perspective lenses, from owners’ representative to geotechnical engineer to the utilities subcontractor and beyond, in order to uncover the true, most useful, and most relevant benefits that plastic pipe has to offer in a modern infrastructure.

If we start with considering a construction project from its inception through completion, the first person we encounter is the owner. Since the owner is financing the project, they will

clearly be very concerned with cost. Keep in mind however, that the cost applicable to the owner almost always extends further than the initial material, labor, and equipment costs. They are typically responsible for the structure long after it has been erected, and therefore the cost associated with efficiency and service life are just as relevant. Moving forward to the civil engineer who is tasked with designing the system, their major concern would be structural integrity. While making an effort to ensure the system is structurally sound and efficient, the civil engineer must adhere strictly to local building code. This becomes relevant in our discussion because each type of material requires unique design considerations, and some are more tedious than others. Longer design time means more billable hours. The flexibility and versatility of plastic pipe is easier to design with, and therefore works to reduce the overall cost.

Next in line to consider is the team of project manager, project engineer, and superintendant who are overseeing the job. Close proximity to each other results in similar if not identical agendas concerning material used. Convenient, since they will be affected the most by this decision as it is their duty to ensure the project is completed within budget and time allotted. This automatically puts cost and constructability at the top of the list. Working closely with this team, the utilities subcontractor or plumber would be the next perspective to consider. Since this is the person, or group of people, in charge of actually installing the pipe they must be well educated in the specific requirements linked with installation of each type of material available. Due to the incredible ease of installation, plastic pipe is typically the favorite among this group of people. It is fairly obvious that constructability would be their biggest concern, but durability would also an important factor. During construction, relatively fragile material does not fare well and if a subcontractor breaks or wastes the material originally given, replacing it will come out of their pocket.

In the long run, those who are ultimately affected the most with this decision also unfairly have the least say in it. The general public, with the exception of small, in-home renovations, has very little say in what type of pipe is used in their lives even though they are the ones forced to use it on a daily basis. On average, a typical person not involved in the industry would not know the ins and outs of pipe choices however they understandably are heavily concerned with almost all key aspects of it.

Not surprisingly, cost seems to be the main topic of concern across the board. If you consider every single element that would impact cost relative to any construction project, there is ample opportunity to save money if plastic is the chosen material. So far we know that the initial manufacturing cost is less, but in addition to that, the shipping cost is also less due to light weight material. Installation is very inexpensive. Plastic pipe is available in longer sections, cutting down on the number of joints although jointing methods for plastic are much easier and faster than any other material anyway. The light weight is once again an asset during installation because no equipment is needed to lift it into place. Plastic is not corrosive, and therefore does not require treatment before back filling. The combination of these attributes eases all construction costs, material, labor, and equipment.

For indoor plumbing, common types of pipe other than plastic are steel and copper. Installation of copper pipe would take several times longer than plastic pipe would on the same project. Copper pipe requires extremely precise cuts on the pipe because the metal’s rigidity allows no forgiveness for dimensional busts as opposed to flexible plastic which rarely needs to be re-cut. After the entirety of the copper pipe pieces are cut, most plumbers dry set the pipe system first to make sure it all fits correctly. Afterwards, they take that out, sweat all of their

pipes, and refit them together to be installed permanently which accounts for excessive installation time.

Ductile iron is significantly heavier than plastic, it will corrode if not wrapped, and you have to use joint restraints which are not necessary when using plastic pipe. All these factors contribute to why plastic is so much easier to install. In addition, ductile iron is far less efficient because calcium and mineral deposits will build up inside whereas plastic pipe will have virtually no build up. PVC has completely replaced clay pipe in sewer design for many obvious reasons. Once again, it is much easier to install for the same reasons mentioned above. Most notable however is the superior durability of plastic pipe. One of the major issues with clay pipe was tree root intrusion, an issue that is virtually non-existent when using PVC.

At this point in the plastic pipe industry, reinforced concrete pipe (RCP) is probably its biggest competition. That being said, plastic still has many advantages in comparison. RCP is very heavy, even in the short sections that it comes in, so it requires heavy machinery to install. Jointing RCP when in a straight line is not very difficult, but when the infrastructure design inevitably calls for a bend, it can get costly and complicated very quickly. Sleeves for RCP must also be reinforced, using more time and materials. In addition, rebar used in this application must be coated with an epoxy that make it resist rusting caused by water seeping through cracks in the concrete. In some instances, a cast-in-place concrete box is necessary at a bend, which eats up a lot of time and money. First the utilities subcontractor would have to place the two pipes that are to be joined at a bend. They then have to build the formwork for the base of the box around the pipes, place the rebar, and of course pour the concrete. Note that the small amount of concrete needed would constitute a short load which often has extra fees linked to it.

Next, the same process must be repeated for the walls and top of the box. All that effort seems excessive for just one joint.

Anytime a relatively new material gets released into the construction industry as a new standard, especially one involved with mass public use, it undergoes rather severe scrutiny. This is exactly what the plastic piping industry has been experiencing throughout recent decades. While the desire to conduct an extensive investigation on any new product is understandable, there comes a time when enough is enough. In an instance such as this, where the product replaces a significant percentage of an existing standard, it is important to understand that much of the information readily available is biased and thus, unreliable. Many of the “major concerns” floating around about plastic piping are often pointed out by competitors in the industry who fear for a loss in demand for their product. To make matters even more confusing, it is difficult to compare materials when they are inherently different. Experimental lab testing is usually material and product specific, making it tricky to define a fair comparison standard. Also, keep in mind the fact that statistics based on newer material are simply less in depth from lack of time. In an effort to navigate the scarce and murky information about this topic it is pertinent to fully understand all of the existing criticisms, their sources, and the motives behind them. Doing so will enable us to make a well-informed decision as to whether or not said criticisms are worthy of concern before drawing any conclusions.

"The design of sewers and culverts requires consideration of the interrelated fields of hydrology, hydraulics, structural behavior, durability, economics, and construction procedures. Knowledge of the performance of a pipe material in each of these fields is essential for complete evaluation and comparison to the performance of other pipe materials. Such knowledge must be based on scientific research and field experience rather than unsubstantiated claims." (ACPA).

This statement is completely true despite the fact that it was pulled from a publication by the American Concrete Pipe Association with the sole intent of undervaluing plastic pipe.

This same article continues on to refute some of the benefits commonly associated with plastic pipe. One of the claims they make is that the light weight of plastic pipe is only deceivingly beneficial, stating that “The same equipment used by the contractor to excavate the trench is used to handle and install pipe”. Since this equipment is most likely going to be on the job site throughout the project, the cost saved from not needing it to install plastic is irrelevant. While their claim about the equipment being on site is true, they omit the fact that it will not be in constant use, saving fuel. Most importantly however, plastic pipe installation is faster than RCP and therefore the job will finish faster and as a result the equipment will leave the site faster.

Furthermore, the ACPA article mentions that plastic pipe’s weight is detrimental when being installed below the groundwater table. If the trench fills with water before backfill is initiated, the pipe could float, causing harm to joints and grade. While true, they fail to mention that other heavier pipe materials must be cleaned out if they have been submerged in water before being completely sealed. This is to remove any soil particles that most likely deposited within the interior of the pipe from the water movement, and it can be time consuming.

Literature similar to this can be found almost anywhere, making it hard to filter out the truth about piping material. However, arguments against plastic pipe can be used to help strengthen our research by giving us a guideline for specific topics to investigate. After researching the facts, considering all points of view, analyzing counterarguments, and making specific inferences by comparing materials in unique situations, we can confidently draw

conclusions. Plastic pipe is a revolutionary addition to the industry. Its light weight, durability, low cost and environmental impact are not only vastly impressive but cause a domino effect that trickles down throughout the entirety of the project and remain long after completion.

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