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**Ductile Iron Pipe
Research Association**

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All Pipe Materials Are Not Equal: Ductile Iron Pipe vs. Steel Pipe

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When Ductile Iron and steel pipe are bid against each other on transmission main projects, owners and engineers are often inundated with information relating to various aspects of these competitive materials. The competition is lively, but the facts are sometimes hard to come by. Our purpose is to show areas where Ductile Iron Pipe has distinct, irrefutable advantages over steel pipe. Whether the concern is engineering, installation, or operation, an objective comparison of these two products shows they are not equal. Ductile Iron Pipe's conservative design and ease of installation make it decidedly better.

Ductile Iron Pipe Internal Pressure Design Is More Conservative Than Steel Pipe
Perhaps the most striking difference between Ductile Iron and steel pipe is the relative way their internal pressure designs are modeled. Only Ductile Iron Pipe has a standardized design procedure (ANSI/AWWA C150/A21.50), and the approach in that standard is the most conservative in the piping industry. Steel pipe design is not standardized, although information may be found in the American Water Works Association's Manual of Water Supply Practices, M-11, "Steel Pipe - A Guide for Design and Installation," as well as in "Welded Steel Pipe - Steel Plate Engineering Data - Volume 3" published by the American Iron and Steel Institute, and manufacturers' literature.

Both Ductile Iron and steel pipe use versions of the Barlow hoop stress equation to model internal pressure design. Ductile Iron Pipe utilizes a safety factor of 2.0 in the design pressure, whereas, with steel pipe, the allowable stress is limited to between 50 percent and 75 percent of the minimum yield strength, depending on the magnitude of the surge pressure.

Ductile Iron Pressure Class Design
According to AWWA C150, "Thickness Design of Ductile Iron Pipe," internal pressure design incorporates the working pressure and surge pressure, which are added together prior to applying a factor of safety of 2.0. This is referred to as a pressure class design because the surge pressure is part of the design pressure calculation. The standard surge pressure allowance is 100 psi, which is approximately the surge that would occur in Ductile Iron Pipe if the velocity of flow were to abruptly change by two feet per second. Different surge pressures are handled by substituting them in place of the standard surge pressure allowance. For Ductile Iron Pipe (AWWA C150 standard design), the hoop stress equation is:

$$t = \frac{F_s(P_w + P_s)(D)}{2S}$$

where:
t = pipe net wall thickness, in.
F_s = factor of safety (2.0)
P_w = working pressure, psi
P_s = surge pressure, psi
D = outside diameter, in.
S = specified minimum yield strength of Ductile Iron, psi (42,000 psi)

Steel Pipe Internal Pressure Design Reduces Safety Factor to as Low as 1.33

With steel pipe, design for working pressure is based on 50% of the steel yield strength, a factor of safety of 2.0. It is important to note, however, that surges are allowed to increase the stress in the pipe wall to a maximum of 75% of yield. Allowing the wall stress to increase to 75% of yield is the same as reducing the factor of safety in design to 1.33.

Put another way: if the surge pressure is less than or equal to one-half of the working pressure, the pipe would be designed using working pressure only and a design stress of 50% of yield. In this case, a maximum surge would increase the wall stress to 75% of yield. On the other hand, if the surge is greater than one-half of the working pressure, the two pressures are added and the design stress is increased to 75% of yield. But the effect is the same as discussed above: the factor of safety in design will vary from a maximum of 2.0 (zero surge) to as little as 1.33 (working pressure plus maximum surge). In either case, steel pipe design allows surges to compromise the factor of safety.

For steel pipe, where surge pressures are less than or equal to one-half of the working pressure, the hoop stress equation is:

$$t = \frac{(P_w)(D)}{2S}$$

where:
S = allowable stress, psi
  = 50% yield strength of steel

But for steel pipe where surge pressure is greater than or equal to one half of the working pressure, the hoop stress equation becomes:

$$t = \frac{(P_w + P_s)(D)}{2S}$$

where:
S = allowable stress, psi
  = 75% yield strength of steel

Comparison of Design Approaches

The differences in these design approaches lead to some very interesting comparisons, all of which highlight the highly conservative design of Ductile Iron Pipe. For comparative purposes, Equation 3 can be used to design Ductile Iron Pipe as well as steel pipe, except that Ductile Iron Pipe will always limit the allowable stress to 50 percent yield strength, which corresponds to its factor of safety of 2.0. As an example, if we are given a 48-inch transmission main operating under a working pressure of 150 psi but where surges are assumed to be 75 psi, the relative wall thickness calculations shown in Table 1 would result. We will assume for this comparison that both Ductile Iron and steel have yield strengths of 42,000 psi.

The differences in the wall thicknesses are remarkable. This results from two facts:

• Ductile Iron Pipe has an outside diameter that is typically larger than steel pipe in the 48-inch size. This accounts for a small difference in wall thickness.
• Second, and more importantly, steel pipe design allows wall stress to build to 75 percent of yield (safety factor of 1.33) if surges occur. This is why in Table 1 the two steel pipe wall thicknesses are the same although their design pressures are different.

The result here is that Ductile Iron Pipe has a design pressure of 225 psi at 50% yield while steel pipe design uses 150 psi at 50% yield or 225 psi at 75 percent yield. In either case, the result is a calculated wall thickness for steel pipe that is 35 percent thinner than for Ductile Iron Pipe, even though the pipes have the same yield strength.

TABLE 1			
Internal Pressure Design in Accordance with Industry Recommendations (Working Pressure = 150 psi, Surge Pressure = 75 psi)			
	Ductile Iron Pipe (50% Yield)	Steel Pipe (50% Yield)	Steel Pipe (75% Yield)
Design Pressure, psi	225	150	225
Outside Diameter[1], in.	50.80	49.352	49.352
Thickness	0.27	0.176	0.176

But what if our example assumed a surge pressure of 100 psi? The steel pipe design now adds the working and surge pressures and allows the hoop stress to increase to 75 percent of yield. The results for these calculations are shown in Table 2.

Again, the Ductile Iron Pipe design results in a much more conservative approach because the Ductile Iron design doesn't allow surge pressures to compromise the factor of safety.

TABLE 2		
Internal Pressure Design in Accordance with Industry Recommendations (Working Pressure = 150 psi, Surge Pressure = 100 psi)		
	Ductile Iron Pipe (50% Yield)	Steel Pipe (75% Yield)
Design Pressure, psi	250	250
Outside Diameter[1], in.	50.80	49.392
Thickness	0.30	0.196

Comparison of Design at 50% Yield

If both pipes approached internal pressure design using a total pressure design, the 100 psi surge allowance would be added to the working pressure and the wall stress would be limited to 50% of yield. Resulting thicknesses would be as shown in Table 3.

TABLE 3		
Internal Pressure Design Based on 50% Yield (Working Pressure = 150 psi, Surge Pressure = 100 psi)		
	Ductile Iron Pipe (50% Yield)	Steel Pipe (50% Yield)
Design Pressure, psi	250	250
Outside Diameter[1], in.	50.80	49.590
Thickness	0.30	0.295

Here, the 1.7 percent thicker wall for Ductile Iron Pipe now is a function only of the difference in the outside diameters. Both materials have identical yield strengths and the same nominal factor of safety of 2.0. However, Ductile Iron Pipe's conservative wall thickness design doesn't stop here.

Ductile Iron Pipe Design: Service and Casting Allowances

Ductile Iron Pipe design provides additional allowances as part of the pipe wall thickness calculation. A nominal "service allowance" of 0.08 inches is added to the above calculation. Additionally, a casting allowance dependent upon pipe size (0.08 inches for 48-inch pipe) is added. This gives the "total calculated thickness" for Ductile Iron Pipe design and is the thickness one would use to select the appropriate pressure class. Table 4 summarizes the results of what happens when Ductile Iron Pipe design includes its standard allowances and is then compared with the steel pipe examples summarized in Tables 2 and 3.

TABLE 4			
Internal Pressure Design in Accordance with Industry Recommendations (Working Pressure = 150 psi, Surge Pressure = 75 psi)			
	Ductile Iron Pipe (50% Yield)	Steel Pipe (50% Yield)	Steel Pipe (75% Yield)
Thickness, in.	0.30	0.196	.0295
Service Allowance, in..	0.08	—	—
Casting Allowance, in.	0.08	—	—
Total Calculated Thickness, in.	0.46	0.196	0.295

For Ductile Iron Pipe, Pressure Class 150 (nominal thickness = 0.46 in.) would be selected. Steel pipe design would require 0.196 in. or a standard 5-gauge (0.209 in.) wall thickness for the steel pipe designed to 75 percent yield (a factor of safety of 1.33); this is the design that would normally be the result for steel pipe. If the yield strength were held to 50 percent (as is done for Ductile Iron Pipe - a factor of safety of 2.0) the result would be 0.295 in. or a standard plate thickness of 5/16th inch (0.313 in.) for the steel pipe alternate.

Ductile Iron Pipe's service allowance is, really, a traditional nominal wall thickness addition that dates back to Cast Iron pipe design when it was originally called a "corrosion allowance." Of course, the idea of providing sacrificial wall thickness for corrosion control is widely recognized as an ineffective solution, but this thickness allowance has been maintained by the iron industry. It offers

an additional factor of safety, added durability, and provides more than an adequate allowance for scratches and abrasions that can result from handling or the type of superficial surface oxidation that might occur under polyethylene encasement.

The casting allowance accounts for variations in the casting process. Casting Ductile Iron Pipe is a dynamic process that results in slight variations in wall thickness along the length of the pipe being produced. To ensure that this variation does not compromise the factor of safety in design it is added as an allowance. Additionally, required weight tolerances assure that effective wall thicknesses are always greater than calculated net wall thicknesses.

Steel Pipe Allowances for Defects and Mill Tolerances

ANSI/AWWA C200, the manufacturing standard for steel pipe, discusses two allowances as well. However, these allowances are normally left out of the design calculations. The result is that steel pipe design allows the wall thickness required for structural considerations to be reduced, which in turn further compromises the factor of safety of steel pipe.

Section 1.5.1 of AWWA C200 states "…The finished pipe shall be free from unacceptable defects. Defects…will be considered unacceptable when the depth of the defect is greater than 12.5 percent of the nominal wall thickness."

This can be a significant thickness. For our examples summarized in Table 4, 12.5 percent of 0.196 inches is equal to 0.025 inches and 12.5 percent of 0.295 is equal to 0.037 inches.

The second allowance discussed in AWWA C200 is similar to the casting allowance found in the Ductile Iron Pipe manufacturing and design standards. Section 2.2.3 states "…For plate, the maximum allowable thickness variation shall be 0.01 in. under the ordered thickness. For sheet, the maximum allowable thickness variations shall be [0.005 to 0.009 in., depending on nominal thickness]…"

In other words, the plate or sheet used to make the pipe can be 0.005 to 0.01 inches thinner than the nominal thickness for that gauge of plate or sheet. However, this variation is not accounted

for in design as it is for Ductile Iron Pipe. This allowance doesn't seem very large, except when you compare it to the wall thickness that results from the steel pipe design approach. A thin wall is made potentially that much thinner.

If the sum of the defect allowance and the allowance for the mill tolerance is subtracted from the thickness calculations summarized in Table 4, the wall thicknesses in our examples reduce to 0.163 and 0.248 inches, respectively. These are severe reductions. The respective factors of safety now reduce to only 1.11 (normal steel pipe design) and 1.68 (50 percent yield, no design thickness allowances).

Ductile Iron vs. Steel Pipe Design: Comparing Apples to Apples

If the steel pipe industry designed its product with the same rationale as the Ductile Iron Pipe industry, it would add allowances for defects and mill tolerances to the required design thickness and maintain a constant nominal factor of safety with regard to surge pressure design. The resulting Ductile Iron and steel pipe designs would be as shown in Table 5.

TABLE 5 Total Calculated Thickness Incorporating Allowances		
	Ductile Iron Pipe (50% Yield)	Steel Pipe (50% Yield)
Thickness, in	0.30	0.295
Service Allowance, in.	0.08	—
Defect Allowance, in.	—	0.037
Casting Allowance, in.	0.08	—
Allowance for Mill Tolerance, in.	—	0.010
Total Calculated Thickness, in.	0.46	0.342

Ductile Iron Pipe design would, again, result in selection of Pressure Class 150 (nominal wall thickness = 0.46 inches). Steel pipe design, here, would result in selection of 0.342 in. or a nominal 3/8-inch (0.375 in.) wall thickness. Now, the differences between the products are only a function of the differences in the manufacturing of the pipes, not differences in design philosophy. Using this approach, the factor of safety for steel pipe is not compromised.

IT IS EASIER AND LESS EXPENSIVE TO CONTROL CORROSION ON DUCTILE IRON PIPE THAN IT IS ON STEEL PIPE

Steel Pipe Requires Bonded Coatings

Steel pipe requires a bonded coating for corrosion control. The type of coating recommended by the steel pipe industry varies with the manufacturer and market. These coatings are typically either a cement-mortar coating found on steel pipe products in the western United States or a tape-wrap coating found in the eastern part of the country. AWWA standards exist for providing coatings such as coal-tar enamels and tapes, liquid epoxies, fusion bonded epoxies, polyethylene tape-wraps, extruded polyolefins for pipe, and more coatings for specials and fittings.

Cement-mortar coatings are porous coatings that protect ferrous materials through chemical passivation. Unfortunately, some environments are aggressive to cement-mortar coatings. Any damage or degradation of the coating that exposes the steel can set up a corrosion cell that utilizes the potentially large variance in pH between the exposed steel and the steel in contact with the cement as the driving force. This can result in accelerated local corrosion cells. Low pH environments or soils with sulfates are examples of environments that are aggressive to cement-mortar coatings. Soils with high chloride content can be detrimental to cement-mortar coated steel. Additionally, cement-mortar coatings do not offer resistance to potential stray current corrosion. Cement-mortar coatings also reduce the flexibility of the pipe. As a result, the pipe cannot be allowed to deflect as much under external load, nor can internal pressures be allowed to expand the pipe and cause cracking of the coating.

Steel Pipe Coating Imperfections Require Supplemental Cathodic Protection

Tape-wrap coatings (and the others listed previously) are barrier coatings that protect the steel by isolating the pipe from the corrosive environment. They are perhaps more resistant to deterioration and more flexible than cement-mortar coatings. Unfortunately, as is typical with bonded coatings, they tend to require cathodic protection as a supplement. This is because bonded coatings are practically impossible to install without the type of damage that results from shipping and handling from the coating applicator's plant to the job site. The pipe is, therefore, subject to accelerated corrosion cells at local coating imperfections. As a result, steel pipe normally requires an expensive and maintenance-intensive system of corrosion control.

Ductile Iron Pipe Corrosion Control is Accomplished with Polyethylene Encasement

Ductile Iron Pipe and its predecessor, gray Cast Iron, have the same inherent corrosion resistance that makes corrosive environments much less of a concern. And, if there is a concern, the soils along the route of a proposed pipeline can be tested for corrosivity using the 10-point system described in Appendix A of ANSI/AWWA C105/A21.5. If corrosive soils are encountered, an unbonded film of polyethylene encasement in accordance with this standard is the coating that the iron pipe industry generally recommends for corrosion control. It also is the only standardized corrosion control method for Ductile Iron Pipe. This simple and inexpensive method of corrosion control is applied at the job site, eliminating the problems associated with coating damage en route from the applicator. Being unbonded, it also eliminates the concentration of corrosion cells that are a potential problem for bonded coatings. It also makes field repairs very simple to accomplish because no special surface preparations are required. The monitoring and maintenance associated with cathodic protection are not required for this passive system. Since electrical currents are not introduced into the soil, the potential for stray current corrosion damage to nearby structures is avoided. And polyethylene encasement has an effective dielectric strength that protects against most potential stray current environments, including the majority of those resulting from cathodic protection systems on other pipelines.

Ductile Iron Pipe Is Easier To Install Than Steel Pipe

The largest practical advantage of Ductile Iron Pipe compared with steel pipe is that Ductile Iron Pipe is much easier to install properly. Handling, assembling, backfilling, and adapting to field conditions all are areas in which Ductile Iron Pipe offers distinct benefits.

Handling Steel Pipe is a Factor in Wall Thickness Design

Handling steel pipe can actually be a factor in design. The design approach can result in a wall thickness calculation that leaves a pipe not stiff enough or without sufficient beam strength to stand alone during installation. In fact, handling considerations can potentially govern wall thickness design. One may go through the wall thickness design procedure and calculate a required wall thickness based on internal pressure and external load but find that the walls are still too thin to handle the pipe. Therefore, after accomplishing design, a check must be made to ensure that a minimum wall thickness (as a function of pipe diameter) is present.

The relationship between wall thickness and diameter can be used to describe the stiffness of a cylinder. In steel pipe, the stiffness is typically such that stulling, or the placement of braces inside the pipe, must be provided to ensure that the pipe maintains its shape up to the time that the backfill is placed, at which time the stulling can cause unwanted stress concentrations. With Ductile Iron Pipe, no such stulling is required.

Ductile Iron Pipe Push-on Joints

The most popular joint for Ductile Iron Pipe underground applications is the push-on joint. This is a compression ring gasketed joint that is easily assembled and provides outstanding pressure holding capacity. It has been tested to 1,000 psi internal pressure, 430 psi external pressure and 14 psi negative air pressure with no leakage or infiltration. The push-on and mechanical joints are standardized under ANSI/AWWA C111/A21.11, "American National Standard for Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings." Steel pipe has no comparable standard.
There are two types of push-on joints available: the "Fastite" and "Tyton" joints. They differ somewhat in configuration, but both feature a gasket recess that is integrally cast into the bell of the pipe. The compression of the standard dual-hardness gasket results from the pushing home of the spigot. The result is a flexible joint that is easy to assemble and difficult to dislodge or "roll" during installation.

Fastite® Joint

Tyton® Joint
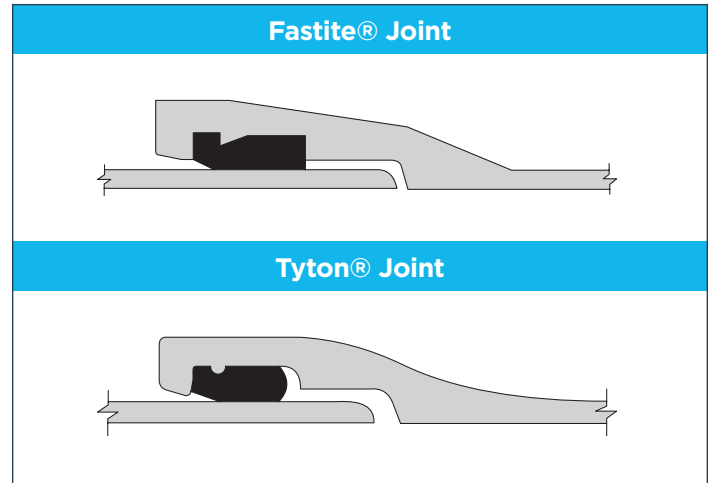
Field Cutting Steel Pipe Gasketed Joints is Impractical

In steel pipe a push-on type of joint is also available. However, rather than using the dual hardness gasket that inserts into the bell, an O-ring type gasket is placed around the spigot. The gasket recess is either fabricated or formed onto the spigot end of the pipe. This type of assembly makes field cutting steel pipe impractical. Further, steel pipe gasketed joints have minimal deflection capacity to assist in routing the pipeline. That is why line drawings and laying schedules are required for steel pipelines. In many cases welded joints are required. This, too, increases installation costs as skilled workers must be used.

Steel Pipe Fabricated Rubber Gasket Joint

Steel Pipe Rolled-Groove Rubber Gasket Joint
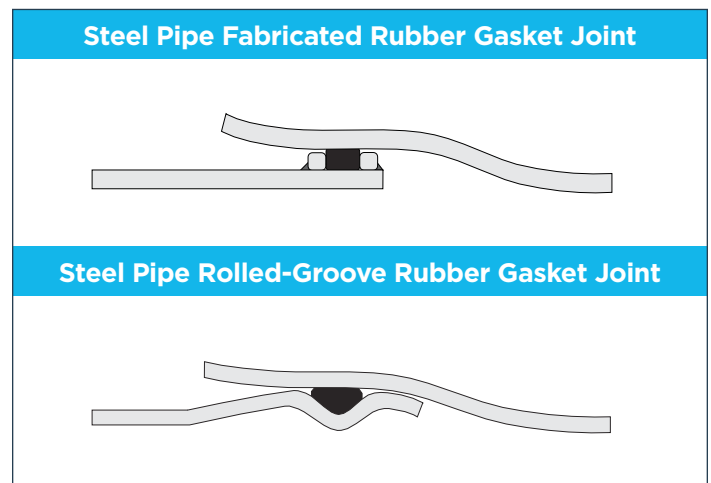
Ductile Iron Pipelines Adapt to Field Conditions in Installation

Ductile Iron Pipe's push-on and mechanical joints are deflectable. This means that the ample deflection capabilities of the joints may be used to help reroute the pipe along curves or around existing underground obstructions, such as existing utilities. Also, since the gasket fits into the bell, the spigot may be cut in the field to make spool pieces. This normally gives the contractor more flexibility in the field than steel pipe can offer. It eliminates the common need for special lengths of pipe to be manufactured and shipped. It allows for a small variety of standard bends to be utilized in construction. It makes laying schedules or line drawings unnecessary. If an existing utility is encountered during construction, special orders for fittings are often not necessary. The joints can simply be deflected to route the pipeline around, over or under the obstruction.

Furthermore, Ductile Iron Pipe is furnished in 18- or 20-foot nominal laying lengths. Steel pipe can be furnished in 20-foot lengths, but is more commonly offered in 36- to 50-foot lengths. This further limits the deflection capabilities and exacerbates handling concerns.

Table 6 shows the minimum rated deflectability of Ductile Iron Pipe push-on joints for selected diameters (other diameters and larger deflections are available) and the maximum deflection available for steel gasketed joints (according to manufacturers' literature).

TABLE 6 Sample Comparisons of Joint Deflection Capabilities		
Nominal Pipe Diameter	Ductile Iron Pipe[2]	Steep Pipe[2]
12	5°	3.49°
16	3°	2.64°
20	3°	2.80°
24	3°	2.34°
30	3°	1.88°
36	3°	1.57°
42	3°	1.35°
48	3°	1.18°
54	3°	1.05°
60	3°	0.94°

Steel Pipe Joints Require "Pointing" and "Diapering"

Of course, welded joints are also available and, as noted earlier, are often used. However, regardless of the type of joint, the jointing procedures are more complicated for steel pipe. First, whether the coating is cement-mortar or a flexible coating, the inside of the pipe joint has a significant area of exposed steel. This requires that the joint be pointed, or covered with cement-mortar after assembly. On the outside, the joints must also be coated either by diapering (cement-mortar coating) or by the application of a bonded coating. Experience has shown that it is unnecessary and undesirable to point Ductile Iron Pipe joints. This is due to differences in material composition and joint design. As a result, there is no need to point the inside of Ductile Iron Pipeline joints with cement mortar. If external corrosion is a concern, the use of polyethylene encasement makes the coverage at joints much more easily accomplished than diapering or applying a bonded coating.

Further, pointing and diapering of steel pipe joints make the joints inflexible. This allows any subsequent differential soil movements to stress the joints, possibly loosening or cracking the mortar and exposing the steel to possible corrosion. Because pointing and diapering are not required for Ductile Iron Pipe, it retains its flexibility throughout the life of the pipeline. This flexibility, in addition to the shorter pipe lengths, makes Ductile Iron Pipelines less susceptible to damage resulting from normal ground movements, and this advantage extends to more violent conditions such as those associated with earthquakes.

Backfilling is Easier with Ductile Iron Pipe

Pipe stiffness is a function of the pipe material's modulus of elasticity and the moment of inertia of the pipe. Since Ductile Iron Pipe design results in a thicker wall for a given set of parameters, Ductile Iron Pipe is a stiffer product than steel pipe.

Further, in calculating stiffness for steel pipe, one accounts for the stiffness of the cement-mortar lining and, if present, the cement-mortar coating. Ductile Iron Pipe's cement-mortar lining is not considered to be a structural component of the product and is not included in the pipe stiffness calculation.

Since Ductile Iron Pipe is a stiffer product, it relies less heavily on the sidefill soils to help support the external load. This means that typical installations do not require select and/or highly compacted

material in order to provide adequate support. Steel pipe, however, requires more design with regard to laying conditions. Where the maximum standard modulus of soil reaction, E', for Ductile Iron Pipe is 700 psi (per ANSI/AWWA C150/A21.50), this is more nearly a minimum or ordinary condition for steel pipe. According to steel pipe manufacturers' literature, an E' as high as 3,000 psi may be needed to prevent excessive deflection. This translates to a select granular material compacted to 95 percent Standard Proctor density to help support a steel pipe alternate and the inspection and diligence to enforce such a specification.

That is not to say that an E' of 3,000 is not possible. If a granular material is placed at 95 percent Standard Proctor density the assumption of an E' of 3,000 may be appropriate. However, Ductile Iron Pipe design is not so optimistic about the reality of obtaining such uniform compaction in general installation. An E' of 700 psi is a very conservative, yet realistic, expectation.

Ductile Iron Pipelines Are More Energy Efficient than Standard Steel Pipelines

Another aspect of comparing Ductile Iron Pipe with steel pipe are the costs associated with operating systems. Cathodic protection systems, often a requirement for steel pipelines, involve higher design and installation costs. They require monitoring and maintenance over the lifetime of the pipeline. There are also costs associated with pumping water through a pipeline and these costs are directly related to pipe inside diameters.

Ductile Iron Pipe Inside Diameters are Normally Larger than Steel

In all normally specified pipe sizes, cement-mortar lined Ductile Iron Pipe has an inside diameter that is larger than the nominal pipe size. On the other hand, steel pipe inside diameters are usually equal to the nominal pipe size. Therefore, for a given flow, the velocity will be greater in steel than in Ductile Iron Pipe. Higher velocities translate to higher head losses and, therefore, greater pumping costs in a steel pipe alternate. When this difference is taken into account, the use of Ductile Iron Pipe can generate significant savings through lower pipeline head losses.

Pumping Costs are Lower for Ductile Iron Pipelines

For example, consider a 24-inch pipeline 30,000 feet long with a flow rate of 5,000 gpm. The actual inside diameter of Pressure Class 200 cement-mortar lined Ductile Iron Pipe would be 24.95 inches compared with 24.00 inches for the steel pipe alternate. The corresponding velocities would be 3.28 fps for the Ductile Iron Pipeline and 3.55 fps for the steel pipeline. The head loss for the entire length of the pipeline would be 36.9 feet for Ductile Iron Pipe and 44.7 feet for the steel pipe alternate. This means that pumping costs would be 17 percent lower for the Ductile Iron Pipeline. This reduction in pumping costs will save the system owner significantly over the life of the pipeline.

Equivalent Head Loss Pipelines

Another way to look at this example would be to determine the equivalent steel pipeline alternate that would be required to meet the head loss of the Ductile Iron Pipeline. This equivalent steel pipeline would require some pipe of a larger size to reduce its overall head loss. The next larger standard nominal size of steel pipe is 26 inches with a corresponding inside diameter of 26.00 inches. The equivalent steel pipeline would consist of 13,954 feet of 24-inch pipe and 16,046 feet of 26-inch pipe. More than half the pipeline would have to be up-sized just to handle the same flow as the Ductile Iron Pipeline.

To offset the increased pumping costs over the life of a steel pipe line, several alternatives may be considered. The increased pumping costs can be annualized and used to determine a present worth value in an economic analysis. This present worth of added pumping costs should be considered an added cost to purchase the steel pipe alternate. Alternatively, equivalent pipeline theories as discussed above could be used or the head losses can be made equivalent by specifying that the inside diameter of the steel pipe alternate be equal to that of Ductile Iron Pipe.

Conclusion: All Pipe Materials are Not Equal

For the engineer, the owner, and the contractor, the advantages of Ductile Iron Pipe abound. The conservative design approach gives the engineer an effective design that is easily accomplished while offering an impressive factor of safety. The contractor experiences the ease of assembly and adaptability of a pipe product that allows field adjustments to minimize costly delays in construction. The owner receives a long-lasting pipe that is easy to operate and maintain, including a simple corrosion control system that requires no cathodic protection and no monitoring or maintenance. And he has the knowledge that unforeseen changes in operating conditions aren't likely to compromise the ability of Ductile Iron Pipe to perform. When comparing Ductile Iron and steel pipe it becomes apparent — all pipe materials are not equal.

Notes

1. Ductile Iron Pipe outside diameters are standardized in ANSI/AWWA C151/ A21.51. Steel pipe outside diameters are typically based on clear inside diameters equal to the nominal pipe diameter. The outside diameter for steel pipe is, therefore, calculated by accounting for the thickness of the cement-mortar lining (0.5 inches for 48 inch pipe) and the steel cylinder thickness.
2. Deflections listed are minimums set forth in ANSI/AWWA C600.
3. Deflections listed are maximums found in manufacturers' literature.

For more information contact DIPRA or any of its member companies.

Ductile Iron Pipe Research Association

An association of quality producers dedicated to the highest pipe standards through a program of continuing research and service to water and wastewater professionals.

P.O. Box 190306
Birmingham, AL 35219
205.402.8700 Tel
www.dipra.org

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Member Companies

AMERICAN Ductile Iron Pipe
P.O. Box 2727
Birmingham, Alabama 35202-2727

Canada Pipe Company, Ltd.
55 Frid St. Unit #1
Hamilton, Ontario L8P 4M3 Canada

McWane Ductile
P.O. Box 6001
Coshocton, Ohio 43812-6001

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Two Chase Corporate Drive
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Birmingham, Alabama 35244

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