Steel Pipe: The Flexible Choice

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Steel pipe is classified as a flexible pipe for design purposes. Concrete pipe is classified as a rigid pipe. For buried water pipelines, one of the major engineering differences is the method for the pipe to withstand the earthload above the pipe. Steel pipe offers numerous options for design of linings coatings and joints. This offers the designer many choices for design considerations. This is a good but problematic situation. What is the best solution to the engineering problem?

Flexible pipes come in many forms. Steel, Ductile Iron, PVC, Corrugated Metal, Corrugated and Profile Wall Plastics. For all buried flexible pipelines, one of the major design considerations is controlling deflection due to the earthload on the pipe. All of these products predict the deflection from earthload with some form of the Modified Iowa Formula. The Modified Iowa Formula is based on the principle of the soil envelope helping to resist the load on the pipe. The major variables in the formula are deflection and the soil property E. Deflection is a constraint on the pipe, the lining, coating, and the joints. E is an empirical value that is an indicator of the soils ability to help resist the load on the pipe.

Most engineers look at the design of steel pipe without evaluating all of the possible solutions. Steel pipe currently has over 20 AWWA standards. This is considerably more than any other pipe material. Steel pipe can come with cement, epoxy, or polyurethane linings. You can get steel pipe with Cement, Polyethylene tape, Polyurethane paint, epoxy, fusion-bonded epoxy, extruded polyolefin and petrolatum tape coatings. You can get rolled spigot o-rings, carnigie o-rings and welded joints. With these numerous options, each choice has its unique advantages.

The obvious solution may not be the best solution. Many times it is in fact better to design the soil than to design the pipe. If the earthload is large, then changes in the wall thickness of steel pipe could become very expensive. Using AWWA guidelines for design, a 48 diameter pipeline with 0.240 wall thickness would withstand an earthload of 20 ft. of cover. To get to 27 ft of cover you would need to increase the wall thickness to 0.500 wall thickness. This would cost about $45/ft of pipe. By changing the backfill from a granular material to crushed rock or flowable fill the deflection is also controlled using the same 0.240 wall thickness. In many locations these backfill materials would cost significantly less than $45/ft of pipe.

Just when you think you have the perfect solution to the deflection design and you come up with the required wall thickness, on the next project someone proposes a different coating. Deflection design is different for different coatings and therefore the process may change. When you change the deflection criteria that may affect the chosen joint.
The City of Houston presently has different steel pipelines in their system with Cement Coating, Polyethylene Tape Coatings and Polyurethane coatings. All have different costs but the same manufacturer supplied all. Why the different materials? Each had a unique advantage at the time. Some had to do with engineering considerations and some had to do with availability and cost.

This may seem confusing and unnecessary when many competing products only require minimal design to specify. Most water pipeline projects where steel is an option are 30 diameter or over. These are major water pipeline projects. With a little extra preparation and design in the beginning there is almost always a savings for the project. This process of design can be made much easier by taking an approach similar to design builds. Create a team of engineer, contractor, supplier and corrosion specialist. The engineer is obviously the lead in this process. He sets the design parameters for the project. He must decide the amount of risk and the corresponding safety factors necessary for all products. He should develop a comfort level with some contractors and suppliers so that each project can be evaluated to see if differing site conditions warrant different material and installation considerations.

This team is not necessarily easy to do on the first project it is attempted on. Contractors and suppliers can be self-serving. The engineer may find help in associations. Through the numerous contractor associations and through AWWA committees it is usually easy to find people who are well respected and will give you a fairly straightforward opinion. If you are not sure or are just starting the process then check out the information through another source until you have a comfort level with the people you are working with.

If you have any questions, please contact **Dr. C.Vipulanandan**