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Joint Restraint vs. Thrust Blocks

The question often arises, "Can you really eliminate thrust blocks using joint restraint?" This report is an attempt to provide the information needed to prove that using joint restraint is a way to avoid using a thrust block. For many years, thrust blocks have been successfully used in distribution systems all over the world. Thrust blocks, however, are not without limitations.

Thrust Blocks Uncovered

There is an argument that thrust blocks are the cheapest form of pipeline restraint. When all of the costs such as pouring, labor, and forming time are added to the price, the thrust block is not as cheap as originally thought.

A thrust block prevents separation of joints and pipe movement by transferring the resultant thrust force at a bend to the undisturbed soil behind the thrust block. The bearing strength of the soil is expressed in pounds per square foot. Therefore, the area behind the thrust block must engage enough soil to resist the resultant thrust force at a change in direction. Thrust block design is commonly determined by the equation $A_b=S_f*T/S_b$. Where A_b is the required bearing area of the thrust block, S_f is the safety factor, T is the resultant thrust force (see Connections Bulletin PD-2), and S_b is the bearing strength of the soil. As an example, for a 90 degree bend in a 12-inch ductile iron pipeline at 150 psi in a soil with a bearing strength of 2000 psf and a safety factor of 1.5:1 the required thrust block bearing area is almost 22 square feet-roughly 6.6 feet by 3.3 feet.

A properly designed thrust block involves much more than dumping a load of concrete behind a bend. The design involves consideration of undisturbed soil, soil bearing strength, test pressure, pipe size, fitting configuration, and trench depth to determine the bearing area of the thrust block. When designing a thrust block, take care to prevent the concrete from covering the joints at the fittings, the weep holes of the hydrants, and the operating mechanisms of valves. Once the thrust block is properly designed and properly formed, a concrete truck is called to the site to pour the concrete. Now the wait begins. The concrete must dry before the pipe is charged with water and tested. This procedure addresses horizontal fittings. When complicated bend combinations, vertical down-bends, parallel lines, dead ends, and future excavation possibilities become involved, the use of thrust blocks becomes very problematic. This report does not begin to explore the complications involved with thrust blocks in locations with poor soil conditions.

Joint Restraint Advantages

A properly designed, restrained pipeline uses the bearing strength and frictional resistance of the soil, essentially, to turn the pipeline into a thrust block. The same basic parameters required to determine the size of the thrust block are used to determine the amount of pipe that must be restrained to resist thrust forces underground. These parameters are pipe size, pipe type, test pressure, fitting type, trench type, depth of bury, soil type, and safety factor. With this information and the various design equations, it is possible to quickly and simply calculate the length of piping that must be restrained.

With over twenty years of experience, it is now a well established fact that not all joints are restrained in order to have a safe system. In the beginning of restrained joint pipeline design, the equations used to determine the length of pipe to be restrained were the subject of much speculation and theory. The equations and soil values used by EBAA are based on actual testing and evaluation. In 1980 and 1981, the Ductile Iron Pipe Research Association engaged in a study to evaluate the various design equations used at the time. Full scale tests were performed on twelve inch ductile iron pipe and forty-five and ninety-degree bends. The results of these tests were used to modify an existing equation and implement soil property modifiers for various trench conditions. These equations have been successfully used for many years. All of the soil properties for the soil to pipe interface were, however, assumed based on tests of pilings to determine the soil friction values for steel. In 1989 EBAA Iron embarked on a soil study to determine actual soil properties on ductile iron, ductile iron wrapped with polyethylene, and PVC pipe surfaces. The combination of the conservative thrust restraint equations and updated soil information is provided in the design handbooks and computer software available from EBAA Iron free of charge.

Using joint restraint opens possibilities that are not available with thrust blocks. When construction is required in congested underground areas, it is next to impossible to pour thrust blocks without interfering with other utilities. Also, the use of thrust blocks in congested areas poses a particular problem when construction or maintenance of a different utility occurs in close proximity to the thrust block. If the soil behind the thrust block is disturbed or if the block is mistaken for a rock that needs removal, then the pipeline fitting is separated from the line. This results in loss of water, property damage, delays, and other costly side effects. Restrained pipelines are installed in congested areas without affecting or being affected by other utilities or future construction. The bearing area of a restrained pipeline is not concentrated in a small area, so excavations in close proximity do not pose the danger that causes problems with thrust blocks.

Continuing with the previous 90 degree bend example but utilizing restrained length design instead of thrust blocks, a comparable 12-inch ductile iron pipeline with a 3 ft depth of bury in a silty-sand with a type 5 trench compaction the restrained length requirement is 28 feet. That is two restraints at the fitting and one restraint on the first line joint back on each leg of the fitting for a total of four restraints. (See Connections Bulletin PD-02.)

Joint Selection

Thrust blocks are commonly used with push-on fittings. This type of fitting is difficult to install, and when pipe is cut in the field extra time and effort are required to bevel the end of the pipe to enable insertion of the spigot into the fitting bell. This requires powered equipment or special rigging tools. Taking a push-on joint apart can be even more difficult. On the other hand, the mechanical joint is very adaptable to changes in fabrication in the field. Pipe cut in the field is easily inserted into the MJ bell and the joint is made by tightening some bolts. Disassembling a mechanical joint to make changes or adjustments is simple and straight forward.

Very little extra effort is required to restrain a mechanical joint fitting after the t-bolts are tightened. EBAA mechanical joint restraint products utilize accepted assembly procedures to seal the joint, then the simple tightening of wedges to restrain the joint. This requires no special tooling or rigging and is performed by one man with hand or power tools. Complex fitting configurations are fabricated outside of the trench and lowered into place for final connections. Additionally, the use of joint restraint products in the design and construction of parallel pipelines eliminates the problem associated with one thrust block being required to encompass another fitting. Once the line is restrained and buried, the line is ready for testing. This hastens the construction process and prevents the need for trenches to remain open for long periods of time. This is not possible with unrestrained joints that require thrust blocks.

Summary

Can you really eliminate thrust blocks using joint restraint? Based on years of experience, the answer is "yes." The use of the EBAA Iron mechanical joint restraint products and proven design procedures allows for reliable installations that effectively eliminate the need for thrust blocks. The use of the mechanical joint enables field adaptability that is not available with all joint restraint products. Pipe can be cut in the field and fittings assembled with simple procedures that allow for the prompt acquisition of materials and completion of construction. All of this combines to provide you with a safe and proven piping system without depleting your resources.

Reference

Ductile Iron Pie Thrust Restraint Design Handbook, EBAA Iron Sales, Inc., 1993.

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