Innovation in Joint Restraint Systems for PVC Pressure Pipe and Fittings



Clean & Safe Drinking Water Workshop

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Thrust forces

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Gasketed joints are made to seal and not to restrain, cannot handle external thrust force loads.

Thrust Forces



Thrust forces result from the creation of unbalanced forces in a pipeline.

In pipelines, these unbalanced forces (thrusts) can cause joint separation.

Thrust Force = Pressure x Area



Thrust Forces



Changes in direction, Tee



Closing Valves & Hydrants



Changes in Size



Dead Ends

Ways to contain thrust forces:

- Concrete Thrust Blocks
- External Mechanical Restraints
- Integral Joint Restraint System







Thrust Restraint Design



Reference manual: AWWA M23 for thrust restraint design



- Change in direction (i.e., bends, tees, elbows and crosses)
- Changes in size, as in reducers/increasers
- Stops at a dead end
- Developed thrusts when valves and hydrants are closed

Size and types of Thrust Block or Joint Restraint depend on:

- Maximum system pressure (including test pressure)
- Pipe Size
- Appurtenance size
- Type of fitting or appurtenance
- Line Profile (i.e., horizontal or vertical bends)
- Soil Type

Thrust Blocks





Function: Transfer and Distribute Thrust Forces in Pipeline to Surrounding Soil Structure

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Thrust Blocks

Designed as a systems with the soil around the fitting Both soil and concrete together take thrust pressure - Soil surrounding pipe is critical Bearing pressure of soil must be strong for effective thrust control

Function:

- Transfer and Distribute Thrust Forces in Pipeline to Surrounding Soil
- Size and Location dependant on soil and type of fitting
- Require appropriate face area to control thrust

Thrust block challenge on-site: Replication of Design

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Installed Per Design



Not Installed Per Design



Thrust Block challenge:



- Replication of design in the field
- Soil bearing capacity of in-situ soils
- Availability of space
- Time required for concrete to dry & cure
- Future excavations



External Joint Restraints

- Soil strength not a critical factor, installed and inspected to insure proper installation, need to conform to ASTM F1674
- Several types available on the market







<u>Function</u>: Pipeline becomes it own Thrust Block... physically prevents joint separation

Resistance to thrust is generated by:

Passive resistance of soil
Friction between pipe and soil



ASTM F1674 – <u>Standard Test Method for Joint Restraint</u> <u>Products for Use With PVC Pipe</u>

- Three Essential Test Requirements
 - Short Term Performance Quick Burst
 - DR18 755 psi (5.21 MPa) for 60-70 sec
 - Long Term Performance 1,000hr Sustained Pressure Test
 - DR18 500 psi (3.45 MPa)
 - Cyclic Fatigue Test
 - 1,000,000 Cycle test Between 94 psi (0.648 MPa) to 188 psi (1.296 MPa)



External joint restraints challenge:

- Requires many separate parts
- Costly, labor intensive installation
- Slows installation of pipeline
- Point loading may cause pipe wall damage
- Larger size casing pipe required due to restraints
- External + Metallic = Corrosion





• Alternate Choice?

Internal Joint Restraint

- Certified to CSA B137.3, NSF, ULC
- Meets the requirements of ASTM F1674, AWWA C900 standards



Pipe Spigot Footprint of Grip Grip Ring with Uni-**Ring Casing in Pipe Directional Serrations** Bell Raceway MSC

Rieber Gasket

Grip Ring Casing Pipe Bell

Bell Raceway

Bulldog Joint Restraint System







- This type of system combines the sealing and restraining functions in the same product.
- Can be used in all municipal pressure pipe applications distribution mains, sanitary force mains to self-restrain PVC pipe bell joints as well as PVC pressure fittings.
- Pressure class 235 psi (DR18), with factory-installed restraint capability; nothing more to do on site.

Bulldog Joint Restraint System

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- The restraining mechanism consists of a chemically-bonded water based coating system protecting the casing that sits adjacent to the gasket in the bell.
- The casing is built into the bell during pipe belling; a gripper ring is manually inserted into the casing after the pipe has been hydro-tested.
- All of these components are installed on the production line in the plant.

Bulldog is labeled for ease of identification.



Integral Joint Restraint System





The Bulldog Restrained Joint is assembled like any other traditional PVC pipe joint.

No tools, external rods, clamps or bolts are required.

By simply pushing the spigot into the bell, the restraining mechanism is activated.

Bulldog Advantages

- Lighter in weight
- No point loading on pipe from wedges
- Corrosion-resistant
- Effortless installation
- Reduces the risk of human error





Bulldog Fittings





• Available in fabricated fittings

AWWA C900 QC Requirements





Quick Burst (60 – 70 sec): • DR18 = 755 psi

Sustained (1,000 hr): • DR18 = 500 psi



Product Demonstration



Product Demonstration



Product Demonstration Lifting 49,000 lbs



How Strong Is It? UTA's Investigation

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The tests investigated the behavior of the Bulldog joint under tensile loads which are significant during trenchless methods of installation

Test Report Published August 2009





How Strong Is It? UTA's Test Apparatus





How Strong Is It? UTA Test Specimens



| Specimen | Nominal Diameter (In.) | Specimen Length (In.) | Min. Wall Thickness (In.) | Dimension Ratio |
|----------|------------------------------|-----------------------------|---------------------------------|--------------------|
| 1 | 4 | 36 | 0.267 | 18 |
| 2 | 4 | 36 | 0.267 | 18 |
| 3 | 6 | 46 | 0.383 | 18 |
| 4 | 6 | 46 | 0.383 | 18 |
| 5 | 8 | 46 | 0.503 | 18 |
| 6 | 8 | 46 | 0.503 | 18 |
| 7 | 10 | 54 | 0.617 | 18 |
| 8 | 12 | 60 | 0.733 | 18 |

UTA's Test Summary



| Specimen No. | Nominal Diameter, Inch | Failure Location | Load at Failure, Lbs | Displacement At Failure, Inches |
|-----------------|------------------------------|---------------------|----------------------------|---------------------------------------|
| 1 | 4 | Bell | 19,479 | 1.67 |
| 2 | 4 | Spigot | 21,237 | 2.48 |
| 3 | 6 | Bell & Spigot | 38,163 | 2.02 |
| 4 | 6 | Spigot | 35,722 | 1.69 |
| 5 | 8 | Spigot | 54,249 | 1.37 |
| 6 | 8 | Spigot | 54,181 | 1.24 |
| 7 | 10 | Spigot | 72,700 | 1.44 |
| 8 | 12 | Spigot | 110,100 | 2.27 |

Case Study South Saint Paul, Minnesota

- 4,400 feet of 8-inch C900 DR18
- (28) 8-inch fabricated PVC pressure fittings
 - 1 cross
 - 4 tees
 - 1 90° bend
 - 14 45° bends
 - 7 22.5° bends
 - 1 11.25° bend



Commercial Development



• Bridgepoint Business Park



http://www.youtube.com/watch?v=xXBRKKXtNbs



Site Conditions



- Water table above trench bottom
- 0.5 Miles from Mississippi floodplain
- Peats and sands, very poor trench conditions
- Many old, abandoned shallow drains
- Some blue clay at trench bottom

Design called for all joints to be restrained

Wet conditions on-site Eagle Claw Tool used for assembly



Acceptance Testing



• All pipe and fittings joints passed the pressure test

MROYAL

- 150 psi minimum for 48 hours
- One segment was at 150 psi for 15 days.

Pilot Project in St. John's 2014

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Portugal Cove Rd 12" Bulldog installed successfully Installation:



Clean the bell thoroughly, make sure the grip ring, gasket and pipe spigot are free of any foreign material before installation.



Installation:



Lubricate the gasket in the bell only.

Position in straight alignment. Mis-aligned pipe requires a much higher force to complete the assembly. Properly aligned, the Bulldog joint can be assembled manually using a prybar, come-along or Eagle Claw tool.

Insertion line should be visible at the bell edge

http://www.youtube.com/watch?v=JFIMbXpv4Bw



Bulldog Open Cut Installation



Backfilling the pipe prior to joint assembly can prevent over-insertion of previous joints.

An initial pressurization will set the joints and may cause some minor expansion of the system. It is a good idea to pressurize the system up to the test pressure for a period of one (1) hour then remove the pressure and add any makeup water before beginning the actual final pressure test.

Embedment material can be used to centre load the pipe and prevent movement.



Necessary Precautions:



- Assembly of the joint can under certain circumstances cause the over-insertion of previously assembled joints.
- Once installed, Bulldog can not be pulled apart.
- Do not lubricate the Bulldog grip ring or the spigot of the pipe.

Follow the manufacturer's installation recommendations for optimum product performance.



Pipe through steel casing:

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Casing Installation



Questions?

Product demonstration.