TR XTREME®

Is your infrastructure capable of delivering critical emergency services during seismic activity?
THE NEED FOR RESILIENCY

DESIGNING FOR SEISMIC RESILIENCY

Designing for seismic events presents a challenging scenario, as it requires a multi-disciplinary approach to solve a multi-disciplinary problem. Permanent Ground Displacements (PGD’s) are the most pervasive cause of damage to pipelines in a seismic event and materialize in the form of faulting, liquefaction, lateral spread, slope failure, and/or settlement. These PGD’s are often the most severe at boundary conditions and careful consideration must be taken in these areas. Often times the criticality of the pipeline determines the amount of geotechnical investigation to locate and estimate PGD’s.

Ductile Iron Pipe is a segmented pipeline and has a long and proven history for survivability in seismic events. The inherent strength of ductile iron allows the pipe barrel to resist large amounts of strain while the gasketed joint allows deflection and provides pull apart resistance when restrained. Ductile Iron Pipe NEVER designs into the yield stress of the pipe wall; therefore, a ductile iron pipeline can be expected to maintain a full service life even after a seismic event. This is a critical yet often overlooked component of seismic design and resiliency.

When deciding if a seismically resilient piping system is need, owners and designers should consider the following questions:

- How critical is the pipeline?
- Does the pipeline have redundancy?
- What is known about the ground conditions?
- What is the desired life cycle of the pipeline?
- How resilient is the pipeline at the upstream and downstream connection points?
- Will failure of this pipeline cause further hazards (i.e. damage bridges and/or critical recovery facilities)?
- What earthquake recurrence is being anticipated?

To provide solutions to these questions, U.S. Pipe offers a broad range of products to accommodate seismic loading. The criticality of the pipeline and the anticipated external loads will determine how resilient of a product to select.
**PRODUCT SELECTION**

Based upon the seismic scenario the designer will need to specify a product that meets the anticipated criteria for survivability. Not every design scenario requires an earthquake resistant product, however designers want to ensure that the correct product is chosen. This can be a challenging task based upon the breadth of available products and configurations.

Designing and installing a seismically resilient waterline often requires the use of non-standard design and installation practices. There are 3 considerations to evaluate during product selection:

1. **CONSTRUCTABILITY**
2. **COST**
3. **PERFORMANCE**

Each owner may weigh these 3 considerations differently and will choose a seismically resilient product that they feel best accommodates the desired criteria. U.S. Pipe offers a broad range of seismically resilient solutions and the table below is intended to help owners and designers evaluate the 3 considerations.

<table>
<thead>
<tr>
<th>CONSTRUCTABILITY</th>
<th>COST</th>
<th>PERFORMANCE</th>
<th>KEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR FLEX - MJ* Fittings</td>
<td>●</td>
<td>●</td>
<td>◖</td>
</tr>
<tr>
<td>TR FLEX - TR FLEX Fittings</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>TR XTREME - MJ* Fittings</td>
<td>◖</td>
<td>◖</td>
<td>○</td>
</tr>
<tr>
<td>TR XTREME - TR FLEX Fittings</td>
<td>○</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>TR XTREME S1 - TR FLEX Fittings</td>
<td>◖</td>
<td>◖</td>
<td>◖</td>
</tr>
</tbody>
</table>

* - Mechanical Joint with Tandem Wedge Action Restrainers

**INTERNATIONAL STANDARD ISO 16134**

Earthquake and subsidence-resistance design of ductile iron pipelines.

<table>
<thead>
<tr>
<th>CLASS</th>
<th>COMPONENT PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>± 1% L or more</td>
</tr>
<tr>
<td>S2</td>
<td>± 0.5% L to ± 1% of L</td>
</tr>
<tr>
<td>S3</td>
<td>Less than ± 0.5% of L</td>
</tr>
<tr>
<td>A</td>
<td>17,000 d lbs +</td>
</tr>
<tr>
<td>B</td>
<td>8,500 d lbs–17,000 d lbs</td>
</tr>
<tr>
<td>C</td>
<td>4,250 d lbs–8,500 d lbs</td>
</tr>
<tr>
<td>D</td>
<td>Less than 4,250 d lbs</td>
</tr>
<tr>
<td>M1</td>
<td>15° or more</td>
</tr>
<tr>
<td>M2</td>
<td>7.5° &lt; 15°</td>
</tr>
<tr>
<td>M3</td>
<td>Less than 7.5°</td>
</tr>
</tbody>
</table>

“L” is the component length in inches
“d” is the nominal pipe diameter in inches
THIRD PARTY TESTING

U.S. Pipe was the first ductile iron pipe manufacturer to test seismically resilient pipe at the Cornell University Large-Scale Lifelines Testing Facility and has subsequently conducted the most third-party testing with Cornell of any pipe manufacturer.

“...The test results and FE simulations presented in this report confirm that the TR-XTREME® joints are able to sustain without leakage, large levels of ground deformation through axial displacement and rotation.”

- Cornell Report

TESTS PERFORMED

1. Tensile Stress-Strain Characteristics of Ductile Iron
2. Bending Tests - 6”/12” TR XTREME®
3. Joint Compression - 6” TR XTREME®
4. Joint Tension - 6”/12” TR XTREME®
5. Axial Soil Pipe Resistance
6. Pipeline Response to Fault Rupture - 6” TR XTREME®

IMPROVEMENTS

Utilizing the test data from the Cornell University testing, it was determined that TR XTREME® 12” - 24” met ISO 16134 Category A for pull apart resistance. However, it was discovered that additional pull apart resistance was needed in 6” and 8” diameter TR XTREME in order meet ISO 16134 Category A. To meet this requirement the bell joint was converted to a HDSS® design to increase the number of locking segments being inserted into the bell slot cavity. An increase in locking segments corresponds with an increase in restraining area against the spigot weld bead; resulting in 6” and 8” diameter TR XTREME meeting ISO 16134 Category A pull apart resistance. Because of the strength gains realized with the 6” and 8”, the larger sizes of TR XTREME were also converted to the HDSS bell design to provide significantly increased pull apart resistance for the entire TR XTREME size range.
**GENERAL INFO**

**Installation**
Three Assembly Stripes for Expanded, Midpoint & Contracted Installation

**Single Slot**
Single slot for inserting locking segments

**Expansion/Contraction**
Elongated Cast Bell Provides 2.9” Stroke with Internal Deflection

**Restraint**
Increased Locking Segments for Increased Pull Apart Resistance

**Gasket**
350 psi TYTON JOINT® Gasket

**Factory Applied Spigot Weld Bead**

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**Dimensional Data**

<table>
<thead>
<tr>
<th>NOMINAL PIPE SIZE</th>
<th>6”</th>
<th>8”</th>
<th>12”</th>
<th>16”</th>
<th>24”</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>INCHES</td>
<td>INCHES</td>
<td>INCHES</td>
<td>INCHES</td>
<td>INCHES</td>
</tr>
<tr>
<td>Pipe Barrel OD - “A”</td>
<td>6.90</td>
<td>9.05</td>
<td>13.20</td>
<td>17.40</td>
<td>25.80</td>
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<tr>
<td>Max Bell OD - “B”</td>
<td>9.69</td>
<td>12.07</td>
<td>17.02</td>
<td>21.62</td>
<td>30.82</td>
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<tr>
<td>Bell Depth - “C”</td>
<td>9.89</td>
<td>10.42</td>
<td>10.98</td>
<td>11.98</td>
<td>12.89</td>
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<tr>
<td>Weld Location - “D”</td>
<td>5.87</td>
<td>6.21</td>
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<td>7.08</td>
<td>7.08</td>
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<tr>
<td>Face to Midpoint - “X”</td>
<td>2.79</td>
<td>2.95</td>
<td>3.18</td>
<td>3.63</td>
<td>4.54</td>
</tr>
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</table>
The first and only domestic earthquake resistant ductile iron pipe that provides expansion/contraction and deflection within a single restrained bell joint connection.

TR XTREME® is manufactured out of ductile iron, a material that has a long and successful history to withstand seismic activity. Joint integrity is accomplished by a robust and unique extended bell that provides 2.9” of expansion and contraction capability with up to 4° of deflection per joint. TR XTREME incorporates technology U.S. Pipe has gained from over 40 years of designing restrained joints for the water works industry.

The TR XTREME joint is one of the strongest and most robustly designed restrained joints for water works, as proven by Cornell University during full-scale 3rd party testing. The TR XTREME seismic joint utilizes the time proven and effective TYTON® Gasket for a reliable seal. It is manufactured in Northern California and is available in 18' lengths up to 24” diameter. Additionally, U.S. Pipe offers a complete line of standard and custom fittings to complement TR XTREME pipe. The features incorporated into TR XTREME help ensure that when disaster strikes, water will be available.

Benefits

- Available in 6, 8, 12, 16, 24 inch diameters
- Only domestic seismic pipe with expansion/contraction & deflection in single joint
- Increased quantity of locking segments for increased pull apart resistance
- Easy boltless assembly and disassembly
- Full line of fittings and adapters for complete resiliency
- 350 psi working pressure rating

Performance Specifications

<table>
<thead>
<tr>
<th>INCHES</th>
<th>POUNDS</th>
<th>PERCENT</th>
<th>DEGREES</th>
<th>LINEAR FEET</th>
<th>ISO 16134 DESIGNATION</th>
<th>AVAILABLE CLASSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZE</td>
<td>ASSEMBLY LENGTH AT MIDPOINT</td>
<td>MINIMUM PULL APART RESISTANCE</td>
<td>EXPANSION/CONTRACTION AT MIDPOINT</td>
<td>JOINT DEFLECTION</td>
<td>RADIUS OF CURVATURE</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>17ft 9.5in</td>
<td>102,000</td>
<td>± 0.68%</td>
<td>4</td>
<td>255</td>
<td>S2, A, M3</td>
</tr>
<tr>
<td>8</td>
<td>17ft 9.5in</td>
<td>136,000</td>
<td>± 0.68%</td>
<td>4</td>
<td>255</td>
<td>S2, A, M3</td>
</tr>
<tr>
<td>12</td>
<td>17ft 9in</td>
<td>204,000</td>
<td>± 0.68%</td>
<td>4</td>
<td>254</td>
<td>S2, A, M3</td>
</tr>
<tr>
<td>16</td>
<td>17ft 8.5in</td>
<td>272,000</td>
<td>± 0.68%</td>
<td>3</td>
<td>338</td>
<td>S2, A, M3</td>
</tr>
<tr>
<td>24</td>
<td>17ft 8in</td>
<td>408,000</td>
<td>± 0.68%</td>
<td>3</td>
<td>337</td>
<td>S2, A, M3</td>
</tr>
</tbody>
</table>
TR XTREME® SPECIFICATIONS

Pipe and fittings shall be manufactured and supplied as follows:

As shown or required by the plans, a Ductile Iron Seismic Piping System shall be furnished and installed such that it has the capacity to deflect, prevent pull apart, and expand or contract to accommodate anticipated seismic ground strains. The piping system shall be capable of achieving the following performance criteria:

Per ISO 16134:2006 Earthquake & Subsidence Resistance Design of Ductile Iron the TR XTREME shall meet or exceed the following classifications:

1. Expansion/Contraction Performance – Classification S2. Minimum expansion/contraction performance of ±0.68% of assembly length.
2. Pull apart resistance – Classification A. The pipe and joint shall be rated to have a minimum 17,000 lbs per inch/diameter (3 d kN) of axial pull apart resistance.
3. Deflection/Radius of Curvature – Classification M3. The assembly shall have a minimum radius of curvature corresponding to Classification M3 for 6”–24” diameters.

PIPE

1. Restrained joint pipe shall be designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with the requirements of ANSI/AWWA C151/A21.51. Push-on joints for such pipe shall be rated to 350 psi in accordance with ANSI/AWWA C111/A21.11 Sealing gaskets shall be NSF/ANSI 61 approved and be constructed of Styrene Butadiene Rubber (SBR) or as noted on project plans.
   - Restrained Joint Pipe shall be gasketed push-on joint with integral boltless restraint and shall be U.S. Pipe TR XTREME or pre-approved equal.
2. Piping system shall be installed with polyethylene encasements, meeting ANSI/AWWA C105/A21.5. Polywrap to be V-bio® enhanced polyethylene encasement.
3. Manufacturer’s certification of compliance to the above standards and requirements shall be readily available upon request.

FITTINGS

Fittings shall be manufactured of Ductile Iron per grade 70-50-05 as specified in AWWA C153 and C110.

Proprietary Restraint - Option #1

- Restrained Joint Fittings shall be push-on with integral boltless restraint and shall be U.S. Pipe TR FLEX or pre-approved equal.
- Friction restraint devices shall not be allowed unless as directed by the engineer.

Mechanical Joint Restraint - Option #2

- Fittings shall be Mechanical Joint in accordance with AWWA C153 and restraint shall be accomplished by Tandem Wedge Restraining Glands.

LINING & COATINGS:

1. Cement mortar lining and seal coating for pipe and fittings, where applicable, shall be in accordance with ANSI/AWWA C104/A21.4. Asphaltic outside coating shall be in accordance with ANSI/AWWA C151/A21.51 for pipe and ANSI/AWWA C110/A21.10 or ANSA/AWWA C153/A21.53 for fittings.

Zinc Coating Option - replace with the following

2. Cement mortar lining and seal coating for pipe and fittings, where applicable, shall be in accordance with ANSI/AWWA C104/A21.4. The exterior of ductile iron pipe shall be coated with a layer of arc-sprayed zinc per ISO 8179-1:2017 “Ductile Iron Pipe - External Zinc-Based Coating - Part 1: Metallic Zinc with finishing layer”.
   - The metallic zinc coating shall have a zinc content of at least 99.99% zinc by mass applied at the minimum rate of 200 g/m² of the exterior surface area. A finishing layer of bituminous paint compatible with zinc shall be applied over the zinc coating.
   - All fittings shall be coated with a zinc-rich paint containing more than 85% zinc by mass in the dried film. A finishing layer of bituminous paint or synthetic resin compatible with the zinc coating shall be applied over the zinc rich paint coating.
   - Repairs to the Zinc Coating: Any damaged area exceeding 5cm² per m² with a minor axis greater than 5mm shall be repaired utilizing either:
     a. Metallic zinc spray complying with this specification, or
     b. Application of a zinc-rich paint containing more than 85% zinc by mass in the dried film
When the highest level of resiliency is needed, TR XTREME® S1 will rise to the occasion while maintaining repeatable simplicity.

TR XTREME S1 seismic pipe incorporates the same TR XTREME® bell along with its features and benefits, however it is supplied in shorter pipe segments to meet the most stringent performance requirements. Shorter pipe segments allow the pipeline assembly to provide larger amounts of expansion/contraction and more deflection to accommodate greater temporary and permanent ground displacements resulting from seismic activity or unstable soils.

Benefits

- Available in 6, 8, 12, 16, 24 inch diameters
- Integral deflection and expansion/contraction provided in each joint
- Shorter segments of TR XTREME to meet the highest performance criteria
- No special assembly procedures or tools required

Performance Specifications

<table>
<thead>
<tr>
<th>INCHES</th>
<th>ASSEMBLY LENGTH AT MIDPOINT</th>
<th>MINIMUM PULL APART RESISTANCE</th>
<th>EXPANSION/CONTRACTION AT MIDPOINT</th>
<th>JOINT DEFLECTION</th>
<th>RADIUS OF CURVATURE</th>
<th>ISO 16134 DESIGNATION</th>
<th>AVAILABLE CLASSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>126 (10ft 6in)</td>
<td>102,000</td>
<td>±1.15%</td>
<td>4</td>
<td>150</td>
<td>S1, A, M2</td>
<td>Class S3</td>
</tr>
<tr>
<td>8</td>
<td>126 (10ft 6in)</td>
<td>136,000</td>
<td>±1.15%</td>
<td>4</td>
<td>150</td>
<td>S1, A, M2</td>
<td>Class S3</td>
</tr>
<tr>
<td>12</td>
<td>126 (10ft 6in)</td>
<td>204,000</td>
<td>±1.15%</td>
<td>4</td>
<td>150</td>
<td>S1, A, M2</td>
<td>Class S3</td>
</tr>
<tr>
<td>16</td>
<td>109 (9ft 1in)</td>
<td>272,000</td>
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<td>174</td>
<td>S1, A, M3</td>
<td>Class S3</td>
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<tr>
<td>24</td>
<td>128 (10ft 8in)</td>
<td>408,000</td>
<td>±1.13%</td>
<td>3</td>
<td>204</td>
<td>S1, A, M3</td>
<td>Class S3</td>
</tr>
</tbody>
</table>
Pipe and fittings shall be manufactured and supplied as follows:

As shown or required by the plans, a Ductile Iron Seismic Piping System shall be furnished and installed such that it has the capacity to deflect, prevent pull apart, and expand or contract to accommodate anticipated seismic ground strains. The piping system shall be capable of achieving the following performance criteria:

Per ISO 16134:2006 Earthquake & Subsidence Resistance Design of Ductile Iron the TR XTREME S1™ shall meet or exceed the following classifications:

1. Expansion/Contraction Performance – Classification S1. Minimum expansion/contraction performance of ±1.0% of assembly length.
2. Pull apart resistance – Classification A. The pipe and fitting joint shall be rated to have a minimum 17,000 lbs per inch/diameter (3 d kN) of axial pull apart resistance.
3. Deflection/Radius of Curvature – Classification M3. The assembly shall have a minimum radius of curvature corresponding to Classification M2 for 6”–12” diameters and M3 for 16”–24” diameters.

PIPE

1. Restrained joint pipe shall be designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with the requirements of ANSI/AWWA C151/A21.51. Push-on joints for such pipe shall be rated to 350 psi in accordance with ANSI/AWWA C111/A21.11 "Rubber-Gasket Joints for Ductile-Iron Pipe and Fittings." Sealing gaskets shall be NSF/ANSI 61 approved and be constructed of Styrene Butadiene Rubber (SBR) or as noted on project plans.
   ▪ Restrained Joint Pipe shall be gasketed push-on joint with integral boltless restraint and shall be U.S. Pipe TR XTREME or pre-approved equal.
2. Piping system shall be installed with polyethylene encasements, meeting ANSI/AWWA C105/A21.5. Polywrap to be V-bio® enhanced polyethylene encasement.
3. Manufacturer’s certification of compliance to the above standards and requirements shall be readily available upon request.

FITTINGS

1. Fittings shall be manufactured of Ductile Iron per grade 70-50-05 as specified in AWWA C153 and C110.
   ▪ Restrained Joint Fittings shall be push-on with integral boltless restraint and shall be U.S. Pipe TR FLEX or pre-approved equal.
   ▫ Friction restraint devices shall not be allowed unless as directed by the engineer.

LINING & COATINGS:

1. Cement mortar lining and seal coating for pipe and fittings, where applicable, shall be in accordance with ANSI/AWWA C104/A21.4. Asphaltic outside coating shall be in accordance with ANSI/AWWA C151/A21.51 for pipe and ANSI/AWWA C110/A21.10 or ANSA/AWWA C153/A21.53 for fittings.

Zinc Coating Option - replace with the following

2. Cement mortar lining and seal coating for pipe and fittings, where applicable, shall be in accordance with ANSI/AWWA C104/A21.4. The exterior of ductile iron pipe shall be coated with a layer of arc-sprayed zinc per ISO 8179-1:2017 “Ductile Iron Pipe - External Zinc-Based Coating - Part 1: Metallic Zinc with finishing layer”.
   ▪ The metallic zinc coating shall have a zinc content of at least 99.99% zinc by mass applied at the minimum rate of 200 g/m² of the exterior surface area. A finishing layer of bituminous paint compatible with zinc shall be applied over the zinc coating.
   ▪ All fittings shall be coated with a zinc-rich paint containing more than 85% zinc by mass in the dried film. A finishing layer of bituminous paint or synthetic resin compatible with the zinc coating shall be applied over the zinc rich coating.
   ▪ Repairs to the Zinc Coating: Any damaged area exceeding 5cm² per m² with a minor axis greater than 5mm shall be repaired utilizing either:
      a. Metallic zinc spray complying with this specification, or
      b. Application of a zinc-rich paint containing more than 85% zinc by mass in the dried film
Fittings

Depending on the criticality of the pipeline, designers will need to determine the level of resiliency of the system. Fittings play a key component in any resilient piping system as they can often act as “anchors” and can be failure points. Designers and owners have two choices when selecting fittings.

MECHANICAL JOINT FITTINGS

Common industry practice involves field cutting pipe and installing Mechanical Joint fittings with Wedge Restraining Glands. This is the most efficient way of locating and installing fittings however there are limitations in the pull apart resistance rating. To maintain as high a pull apart rating as possible, U.S. Pipe recommends using Tandem Restrainers and that the owner or designer seek confirmation from the specific restrainer and bolt manufacturer being considered to confirm the suitability of their product’s pull apart resistance.

RESTRAINED JOINT PROPRIETARY FITTINGS

In high criticality areas where it has been determined that ISO 16134 pull apart Classification A is necessary for the entire system, TR FLEX® Fittings must be used which allow active deflection and uniform pull apart resistance. US Pipe offers a complete line of TR FLEX fittings which can be viewed in the TR FLEX product brochure found at www.uspipe.com.

CLOSURES

A fully integrally restrained system using TR FLEX fittings requires a slightly different approach than most standard installation practices. It requires that the installer utilize closure pieces which are exact length spigot by spigot spools pieces with weld beads that transition between the TR XTREME pipe bells and the TR FLEX fitting bells and are custom fabricated to place the fittings at the desired location.
Designers and installers have three options for producing the closure pieces:

FACTORY MADE CLOSURES
Factory made closures require engineered line drawings to determine the closure piece length prior to construction start up. U.S. Pipe can assist the designer by preparing customized pipeline layout drawings and determining closure piece lengths.

FIELD CUTTING AND WELDING
Field fabrication of the closure pieces requires the installer to measure, cut and apply the weld bead onto the closure piece on-site or at a local fabrication shop. U.S. Pipe can assist by supplying TR XTREME® Weld Kits that provide cutting & welding procedures, a weldable bead and a gauge/template to ensure proper weld bead placement. Please reference the Field Welding Guide as found on www.uspipe.com for more information.

MULTI-BEAD
Multi-Bead Kits can be ordered from U.S. Pipe which provide TR XTREME Pipe to TR FLEX® Fitting transition pieces that permit cutting at various locations along the pipe’s length to enable fitting placement to within 6 inches of the desired location. Once the Multi-Bead piece is cut to place the fitting, the remaining piece is not wasted but instead used further down the pipeline as a regular piece or to be cut again to place another fitting.

<table>
<thead>
<tr>
<th>SIZE</th>
<th>TR XTREME</th>
<th>TR FLEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5.87</td>
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</tr>
<tr>
<td>8</td>
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<td>5.15</td>
</tr>
<tr>
<td>24</td>
<td>7.08</td>
<td>5.15</td>
</tr>
</tbody>
</table>

TELESCOPING SLEEVES
Telescoping Sleeves can be utilized with either Factory Made Closures or Multi-Beads to enable more precise fitting placement. The Telescoping Sleeve units are available with TR XTREME or TR FLEX ends and are placed between the last pipe length and the fitting to provide length adjustment of between 10” and 20” (depending on size). Because of the sleeve’s large expansion / contraction capability they cannot be used where fully restrained pipe, i.e. extended joints, are being utilized.
DESIGN CONSIDERATIONS

THRUST RESTRAINT
When utilizing connections that allow expansion and contraction, it is important that designers provide proper thrust restraint to ensure safe and reliable system operation. There are two general approaches to providing thrust restraint for seismically resilient pipe systems.

JOINT EXTENSION
Restraint can be accomplished by installing the TR XTREME® pipe joints in a fully extended position as shown in the Installation Instructions Option “C”. This will transfer thrust forces axially along the barrel of the pipe. Under this option a thorough Thrust Restraint Design must be undertaken to determine the minimum restrained length. An appropriate design tool can be found on the Ductile Iron Pipe Research Association (DIPRA) website at www.dipra.org. This method of thrust restraint is ideal for installations in liquefaction zones or with soft organic soils where thrust blocks cannot be used.

THRUST BLOCKS
Restraint can be accomplished by installing thrust blocks at fittings which allows complete expansion and contraction of the piping system. For suggested design procedures design engineers should refer to the current DIPRA publication “Thrust Restraint Design for Ductile Iron Pipe”.

THRUST RESTRAINT OPTIONS

POLYETHYLENE ENCASEMENT
TR XTREME® joints should be installed with Polyethylene Encasement to ensure any intended movement is not hampered by debris or dirt in the joint. Additionally, polywrap has been shown to reduce the friction between the pipe and soil during a seismic event which reduces axial pullout force. If corrosive soil environments are encountered, Zinc Coating or V-Bio® Enhanced Polyethylene Encasement should be specified. Installation should be in accordance with AWWA C105.
VALVE, FLANGE, AND HYDRANT CONNECTIONS

FLANGE ADAPTER
Ductile iron flange adapters are available for connections to valves, fittings, hydrants, and structures. These allow seamless transitions to flanged connections, while maintaining joint flexibility. Flange adapters are available with TR FLEX® or HDSS® bell ends.

HYDRANTS
Hydrants are one of the most critical appurtenances in a seismically resilient pipeline as they provide water for fire suppression and act as a regional water depot for post-earthquake recovery. Each jurisdiction has a preferred connection method and U.S. Pipe offers a variety of products to maintain resiliency. TR FLEX® and HDSS® flange adapters allow active deflection at a rigid flanged connection. A SAM1® Seismic Fitting or M-FLEX® ball joint can be utilized to provide large amounts of deflection and/or expansion and contraction.
1. The gasket seat and locking segment cavity of the TR XTREME® bell must be clean and free of debris or any foreign matter.

2. Install the gasket in the bell as per standard TYTON® gasket instructions. Do not lubricate the gasket prior to installing in the pipe bell.

3. Lubricate the gasket and the spigot end to the weld bead of the mating pipe with subaqueous lubricant. This lubricant is not water soluble and will not wash off. DO NOT USE STANDARD TYTON GASKET LUBRICANT.

4. Position the pipe bell with the slot in the 12 o’clock position; this will enable easy insertion of the locking segments, especially in larger pipe sizes.

5. Insert the spigot end into the mating pipe bell keeping straight alignment. Push the spigot to the second stripe (option B). Exercise caution not to alter the position of the previous joint.

6. Insert the locking segments (large end first) into the pipe bell slot and alternate sliding the segments right and left, allowing them to slide to the bottom of the pipe bell. Continue sliding the segments around the pipe joint until all the segments are inserted.

7. Install the Rubber retainer between the locking segments inside the pipe bell slot.

8. Each spigot end of TR XTREME has 3 assembly stripes that allow the installer to assemble the pipe at 3 pre-determined assembly locations depending on what the design requires.

9. Position the spigot at the desired insertion line and deflect the joint as needed. Do not exceed the amount of deflection listed in table 1, or as directed by the engineer.

**TR XTREME Restrained Joint Pipe - Table 1**

<table>
<thead>
<tr>
<th>SIZE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>SEGMENTS</th>
<th>RUBBER LOCKING RETAINERS</th>
<th>PULLOUT (TOTAL TRAVEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6.90</td>
<td>9.69</td>
<td>8.47</td>
<td>3</td>
<td>1</td>
<td>2.90</td>
</tr>
<tr>
<td>8</td>
<td>9.05</td>
<td>12.07</td>
<td>9.00</td>
<td>3</td>
<td>1</td>
<td>2.90</td>
</tr>
<tr>
<td>12</td>
<td>13.20</td>
<td>17.02</td>
<td>9.56</td>
<td>5</td>
<td>1</td>
<td>2.90</td>
</tr>
<tr>
<td>16</td>
<td>17.40</td>
<td>21.62</td>
<td>10.47</td>
<td>6</td>
<td>1</td>
<td>2.90</td>
</tr>
<tr>
<td>24</td>
<td>25.80</td>
<td>30.82</td>
<td>11.47</td>
<td>12</td>
<td>1</td>
<td>2.90</td>
</tr>
</tbody>
</table>
**Option A-Collapsed** – Correct assembly is determined when the front edge of the assembly stripe furthest from the spigot tip lines up with the face of the pipe bell as viewed from above, leaving only one assembly stripe shown.

**Option B-Midpoint** – Correct assembly is determined when the front edge of the middle assembly stripe lines up with the face of the pipe bell as viewed from above, leaving two assembly stripes shown.

**Option C-Extended (Restrained)** - Correct assembly is determined when the front edge of the assembly stripe closest to the spigot tip lines up with the face of the pipe bell as viewed from above, leaving three assembly stripes shown. This is the proper assembly when immediate joint restraint is required.

**Installation Tips (Figure 1)**

Ensure that bell slot cavity is at the 12 o'clock position. Marking this location will make for easier installation.
Materials and specifications are subject to change without notice. Images may be rendered examples and are not necessarily representative of final engineering production pieces.

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