BOLTED SLEEVE TYPE COUPLINGS AND MECHANICAL EXPANSION JOINTS FOR PIPING SYSTEMS

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BOLTED SLEEVE TYPE COUPLINGS

A Bolted Sleeve Type Coupling (BSTC) consists of a Center Sleeve (Middle Ring), two End Rings (Followers), two wedge shaped gaskets and a set of Fasteners (bolts & nuts). The center sleeve has a conical form at each end to receive the wedge portion of the gasket. Tightening of the fasteners draws the end rings toward each other, compressing the gaskets in the space between the ID of the center sleeve and the OD of the pipe surface. When properly installed, this results in a flexible long term seal.

stress formula \( S = \frac{PD}{2T} \) and is directly proportional to the internal design operating pressure and the outside diameter of the pipe involved. As the diameter of the pipe is increased, the end rings must correspondingly increase in cross section size to overcome the rolling stresses introduced during installation. The bolt spacing is inversely proportional to internal design operating pressure.

The most important component of the BSTC is the gasket or elastomeric sealing ring. The compound or material must be capable of retaining pressure load, temperature variation, vibration, impact and flexing that may be caused by many variables in the pipeline system. The flexibility of the coupling joint is obtained by deformation in the gasket area.

Longitudinal pipe movement caused by thermal conditions is absorbed in the coupling without slippage of the pipe on the gasket due to the flexibility and resilience of the gasket. Deflection can also be accommodated in this joint to absorb conditions such as ground settlement, temperature variation and deflection.

A BSTC will allow 3/8\(^\text{"} \) expansion and contraction per joint, which can accommodate the movement of a 40 foot pipe section with 120 degree (F) differential.

A coupling joint is usually referred to as a flexible joint
because it will absorb (without leakage or harm) all ordinary stresses produced while the line is being installed, and those caused by normal expansion and contraction, deflection and vibration movement of the line after it is installed and operating under pressure. The absorption of these stresses per unit of each pipe section is isolated at the pipe ends. The BSTC must be allowed to "float" on the properly supported pipe ends.

BSTC’s can be produced to accommodate a wide variety of diameter ranges, 1/2" to 30 feet, and can be used to:

1. Connect plain pipe ends
2. Connect pipe ends of the same nominal size, but of differing diameters
3. Provide ease of installation and future accessibility for repairs and adjustment.
4. Provide angular deflection in pipe lines
5. Reduce vibration
6. Take up minor lateral displacement
7. Act as wall sleeves
8. Isolate the pipe ends from each other to prevent galvanic action by using an insulating gasket(s).

Bolted Sleeve Type Couplings can be used to connect plain end pipe, and no threading, bevelling or welding is required.
BSTC are used to join pipes of the same nominal size but different outside diameters, such as transitions or reducers. Flanged Coupling Adapters are used to connect flanged fittings with plain end pipe. Note that when FCA's are used, only 1/2 of the 3/8" movement is accommodated. Insulating gaskets are used with BSTC where there is a requirement to electrically isolate the two pipe ends to prevent galvanic action.

BSTC's make equipment installation easier. Exact dimensioning or alignment is not necessary, plus it will provide for easy future disassembly. BSTC are frequently used to connect "Rollout" sections within the penstock, allowing easy access for maintenance purposes to valves or other equipment inside the pipeline.

BSTC will allow for angular deflection. Couplings can be used where the criteria for design at the site requires the entire pipeline structure to be as flexible as possible in order to withstand transverse forces, adjustment for misalignment and yet offer the best protection against water loss. In larger penstocks, where couplings are used between ring girders in conjunction with sliding bearing surfaces, the flexibility and thermal provisions permit the coupling to be used as a universal joint between the two pipe sections and still remain watertight.

Coupling deflection capabilities may be designed deliberately into a pipeline to accommodate "pulling" of the pipe sections around curves or bends within the deflection capabilities of the coupling used. Whenever BSTC's are used, each pipe section "floats" in the joint and is safe from shock. Vibration movements caused by rotating equipment like pumps and motors, or vibration caused by street traffic, do not adversely affect the efficiency of the coupling joint.

Parallel offset, or lateral displacement, between two pipes
can be accommodated only by using two couplings and a suitably sized spool piece. Such a situation is often encountered where minor misalignment or offset is caused by two blind parallel lines not meeting at grade in the closure area. Most ground is subject to shifting and settling at one time or another. Ground settlement can be accommodated by using two couplings and a spool piece.

**GROUND SETTLEMENT ( DISPLACEMENT - Y )
ABSORBED BY TWO COUplings**

![Figure-7](image)

BSTC's with a wall ring may be used to pass a pipe section through a wall or bulkhead, assuring a leak free joint, as well as providing a seal between the wall and the outside or inside environment. This wall ring will also permit easy future pipe removal, and absorb any transfer of stresses resulting from expansion or contraction.

To achieve longer maintenance free operations, pipe couplings must be properly installed according to the manufacturers installation instructions. All manufacturers stipulate that within the area of the seal, the OD of the pipe surface must be clean, even and free from flats and indentations. In addition, if pressure ratings are to be maintained, certain dimensional tolerances must be adhered to. A certain length of the OD of the pipe end must meet the tolerance requirements of the manufacturer so that the coupling can function properly. The coupling center sleeve and one end ring should be allowed to slide completely onto one pipe section to allow for later easy access or removal of a section of pipe.

When planning for special linings (ID) or coatings (OD), consideration should be given to assure that pipe ends comply with the coupling manufacturers tolerance requirements. The smoothness of the surface, the thickness of the material being applied and the adhesion quality of the prepared surface are some of the criteria to be considered.

Generally, different components in a piping system are interlocking, so when pressure is applied no independent movement occurs. However, situations may be experienced where individual parts are free to move, i.e., in a slip joint, or a BSTC. Such a situation exists at a closed valve installed between two couplings. Pressure acting on the closed valve will create a thrust. Similar situations, but to a lesser degree, exist at tees, bends, caps or reducers, which are separated from the remainder of the system by a flexible joint. To prevent the pipe ends from pulling out under pressure, the full thrust must be restrained by thrust blocks, anchor blocks or harness assemblies.

Large diameter couplings are usually custom made for a particular design and for specific outside diameters. The criteria which guides the designer for these specific instances are:

1. Outside diameter of the pipe including paint thickness.
2. Working pressure (or test pressure) of the pipeline.
3. Type of service and operating temperature range.
4. Anticipated angular deflection of the pipes.

**MECHANICAL EXPANSION JOINTS**

Mechanical Expansion Joints (MEJ) are used to accommodate up to 10° of longitudinal pipe movement. The MEJ consists of a body, slip pipe, packing chamber, end ring(s) and anchor rings, if limit rods are used. The packing chamber contains usually five (5) rings of rubber seals alternating with four (4) lubricating seals designed to withstand the internal design pressure.

MEJ's only accommodate expansion and contraction between properly supported pipe sections. The pipe movement must be in a straight line. There is no provision to allow angularity (or differential settlement) between the pipes when these joints are used, since MEJ's will not absorb deflection or shear displacement. The adjacent pipe ends must be properly supported and any movement taking place must be limited, aligned and guided. To achieve this, pipe anchors and guides must be used.

The purpose of any pipe anchor is to divide a pipeline into independent expanding and contracting segments. The thermal expansion of the pipeline can not be controlled, therefore it becomes the function of the pipe anchor to limit
and control the amount of movement. Wherever there is a horizontal or vertical change in direction, it is necessary to provide anchors at the elbow. Straight pipe sections must be isolated so that only linear pipe movement is experienced by the pipe and expansion joints.

The main force acting against anchors is static thrust, which is the force necessary to compress the MEJ its full rated movement, and, frictional force, due to alignment guides and supports. Forces necessary to activate slip pipe movement depends on a number of variables, but a value of 600 X pipe diameter in inches is a good approximate value used in the design of pipe supports.

If more than one MEJ is installed in a series, limits rods are required to restrict the movement in each MEJ in the piping system.

MEJ can be manufactured in sizes from 2" up to 160" in diameter for various pressure applications. MEJ's are manufactured with a variety of ends, such as plain ends, Victaulic or flanged ends, or plain ends fitted with special mounting rings. These special mounting rings can be implemented into the design to facilitate insertion into older penstocks that have pipe ends of irregular or uncertain dimensions. These mounting rings can be either manufactured to mate an existing bolting flange or solid rings welded to the ends of the MEJ.

The outer surface of the slip pipe that comes into contact
with the packing chamber seals must be protected. Chrome plated mild steel, stainless clad mild steel, or stainless steel may be considered.

MEJ's can not effectively be installed on buried pipe. On buried lines, MEJ's must be installed in a vault for proper operation. When installing MEJ's, the open, closed and initial laying length (installed) must always be considered before installing in a vault so future accessibility for repacking or maintenance may be available.

MEJ and BSTC's are flexible joints, and play a very important role by absorbing pipe movement. Neither of these joints will operate properly if used in shear conditions, nor will they protect against pipe pull out under pressure. Couplings will provide for deflection and axial movement of 3/8". MEJ's will provide for much more pipe movement, but will not accommodate pipe deflection.