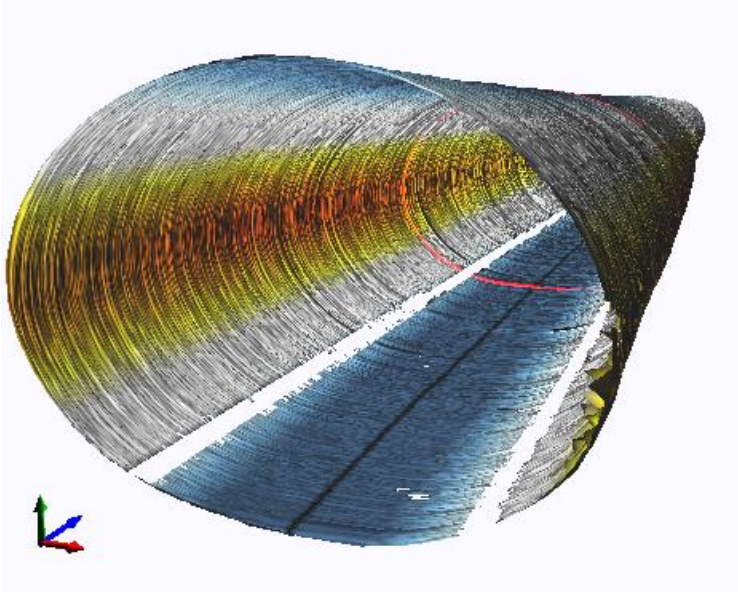
A Crash Course on Pipeline Ovality

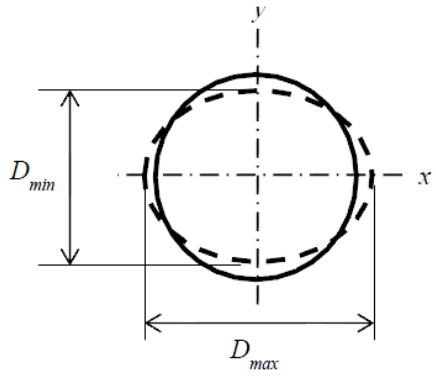


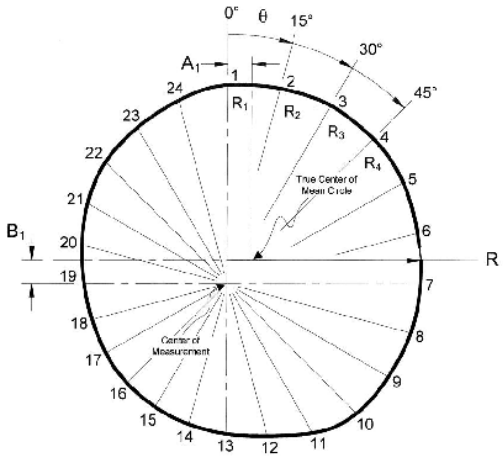
There has been a lot of industry talk about pipeline ovality lately, especially concerning large diameter pipelines with high diameter/thickness (D/t) ratios. Wide spread use of high strength steels, which allow for thinner walled pipes, combined with advances in pipeline inspection technologies, have sharpened this focus. Technological advances and industry collaboration on best practices aim to ensure the safety and longevity of the world's pipelines. Owners and contractors are being proactive by continually improving design and construction standards to limit ovality at the source.

What is Ovality

Simply put, ovality occurs when a pipeline 'ovals' from its original circular shape - the pipe is no longer perfectly round. Although any pipe will oval under the right amount of loading, pipelines with high D/t ratios (diameter over thickness) are most susceptible. Ovality can be categorized as either symmetric or arbitrary out-of-roundness. The percentage of ovality – how far it is from its original circular shape - is calculated based on a simple formula (see figure 2).

$$\text{Ovality } \% = 2 \times \left[\frac{D_{max} - D_{min}}{D_{max} + D_{min}}\right] \times 100$$





(a) Symmetric Ovality **(b) Arbitrary Out-of-Roundness**

Ovality is most likely to occur in two situations: during the pipe joint fabrication process (arbitrary out-of-roundness) and from externally applied loads during and following the pipeline construction phase (symmetric ovality). This brief article only addresses symmetric ovality. Most industry codes provide guidance on the acceptable percentage of ovality for pipeline bends (e.g.

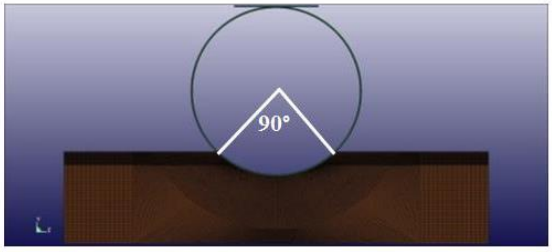
CSA Z662 limits it to 5%), however, there is variation in the acceptance criteria for ovality of straight pipe sections.

How Ovality Effects Pipeline Integrity

Excessive pipeline ovality can raise several concerns for long term pipeline integrity. Ovalized sections of pipe require less force to collapse vs round. Ovality may also have a negative effect on the integrity of the pipe coating where excessive deformation may result in damage. Even in cases where it is easy to re-round the pipe, damage can occur. Re-rounding the pipe cross section can induce a bending stress, weakening the pipe and making it more susceptible to oval again, and even collapse under stress. Early detection and correction of excessive ovality is paramount in ensuring long term pipeline safety. Prevention is key to reducing costly excavations and repairs when ovality is discovered after hydrostatic testing or anytime during the lifecycle of the pipeline.

Pipeline Ovality During Construction

In many cases *symmetric* ovality that occurs during pipeline fabrication and bending can be detected and corrected before it becomes a problem. Pipeline ovality that occurs during the construction process can be trickier to discover. The pipeline must be properly supporting, ideally with 90 degrees of support during all phases of construction to limit the stress placed on the pipe.



Uneven trench bottoms can be a major contributor to excessive or point loading, especially in areas of pipe sag or overbend where it is often difficult to match the trench excavation to the exact curvature of the pipe, resulting in a lack of support and excessive stress. Areas of soil transition such as tie in welds or road crossings, where the trench is over excavated are also frequently of concern. Once welding is complete, it can be difficult to properly compact the soil beneath the pipe to the level of the surrounding, consolidated/virgin soil. This difference in compaction can cause a great amount of stress at the consolidate/unconsolidated soil transitions.

Pipe contact with hard surfaces like rocky terrain, frozen soil or even compressed sand bags can easily result in dents or excessive ovality. The risk must be mitigated with proper pipeline support.

Solutions to Pipeline Ovality

Maintaining proper construction practices and inspection are key. Trench bottoms and pipe bending must be closely monitored and compared to ensure even pipeline contact. The earlier potential areas of concern can be discovered and addressed, the more likely ovality and denting can be avoided.

One easy solution that has been recently developed are the use of structured pipeline pillows (SPP) like PipePillo®. PipePillos are an *engineered* support designed as a long term in-trench solution to pipeline ovality and denting. With proven technical capabilities, proper PipePillo spacing can be calculated – no guessing involved. PipePillo's can be placed in the trench prior to pipe placement or loosely tied to the pipe prior to lowering in. Tying to the pipeline ensures PipePillo's, with their 90 degrees of support, will

be the primary support, even if they still do not touch the trench bottom. Once backfilling progresses, the fill will work its way beneath the pipe and the PipePillo.

PipePillo's can also be stacked to achieve a higher level of support where needed. This is particularly useful in areas of deep excavation such as tie-ins, road bores or even integrity digs. When stacked from virgin ground, any pipe settlement can be negated.

Other areas where the strength of PipePillo's can be utilized (wrong word!) are right at the transition area. A couple PipePillo's at the transition from rock to soil (on the rock side) will help distribute any loading and avoid areas of stress concentration.