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## What Are The Limits?

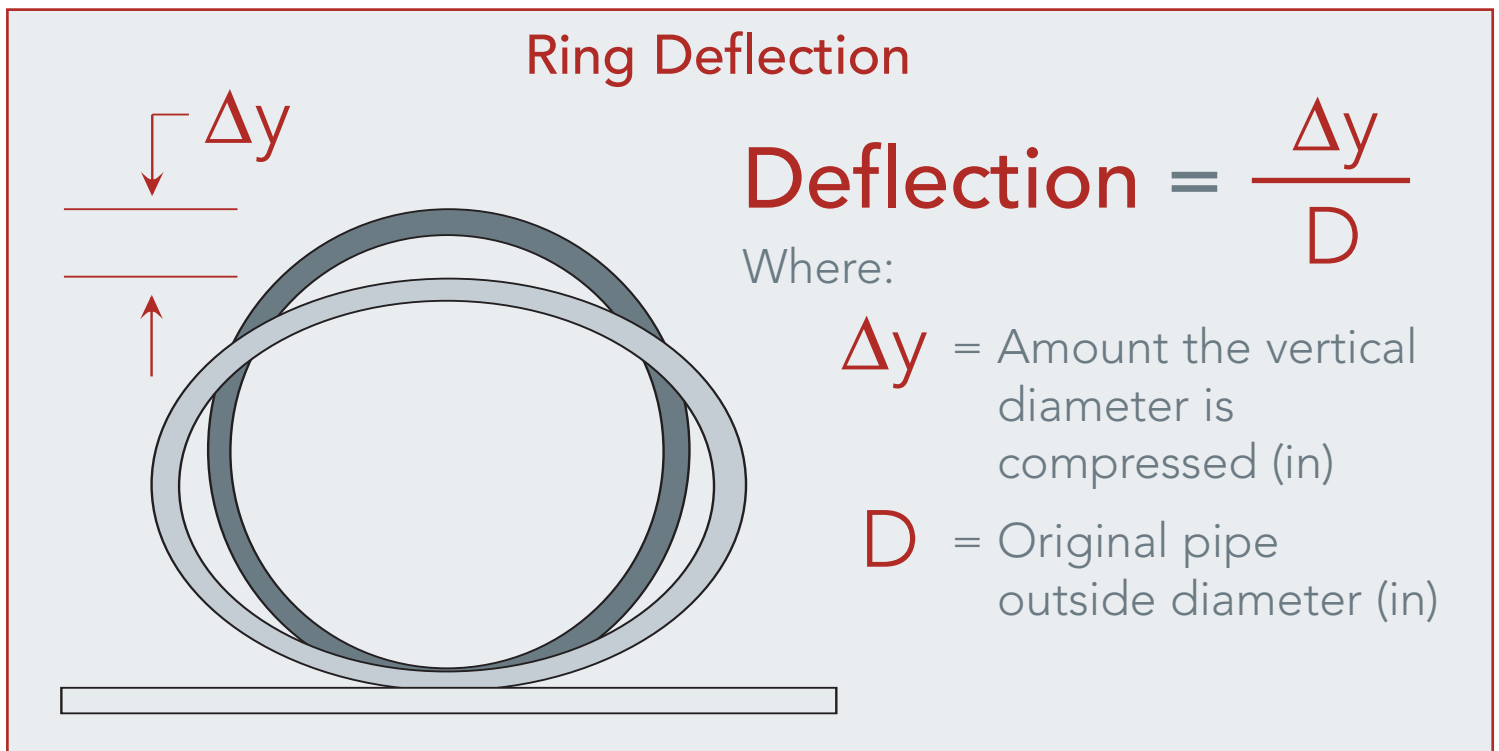


Figure 1: Ring Deflection

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**S**ewer pipe systems are an essential part of any city's infrastructure, and they help to prevent the spread of diseases by providing adequate sanitation. Since their introduction into North America in the late fifties and early sixties, PVC sewer pipes have seen their use steadily increase to the point where they are now the number one choice for the construction of sanitary sewer systems. An excellent strength-to-weight ratio, combined with superior flexibility, durability, and unequalled corrosion resistance are amongst the main reasons for their widespread popularity. PVC sewer pipes are also easy to install and require very little maintenance in order to achieve a high level of performance.

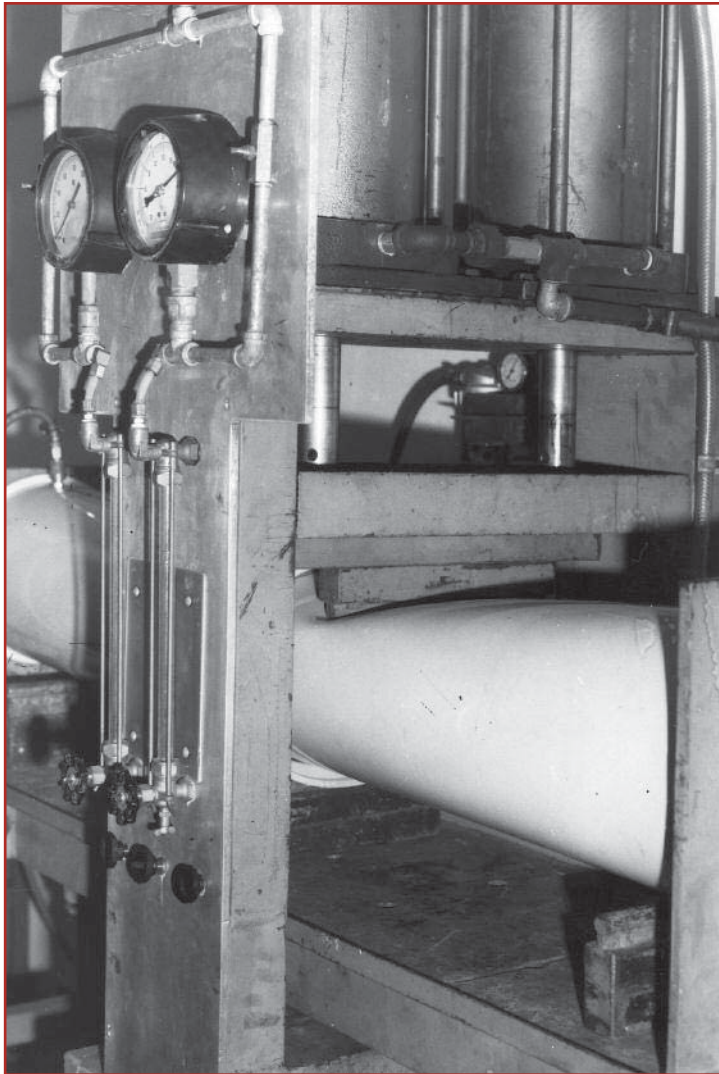


Figure 2. 10" Sewer pipe (ASTM D 3034) under 35% deflection and vacuum of 10.8 psi without losing joint integrity.

Deflection testing of PVC sewer pipe is a tool that allows you to confirm that your sewer system is properly installed and will provide a high level of service. But did you know that the recommended deflection limit provides you with a safety factor of 4.0? (The type of deflection being discussed is ring deflection as shown in Figure 1.)

Research conducted at Utah State University [1] has shown that PVC pipe will require a deflection greater than 30% before it is likely to experience inverse curvature. After inverse curvature, the Modified Iowa Equation can no longer be relied upon to accurately calculate the deflection. Furthermore, pipe joints have demonstrated their ability to remain leak-free at deflection levels beyond 30%. (See Figure 2.) This type of data was critical information for the American Society for Testing and Materials (ASTM) when they decided to apply a safety factor of 4.0 against inverse curvature and joint performance to arrive at the 7.5% deflection limit recommended in the product standard [2].

Questions regarding long-term performance have also been answered. A research project at Utah State University subjected

PVC sewer pipe specimens to various levels of constant deflection, from 5% to 50%, at different temperatures. After 22 years, these specimens exhibited no sign of cracking, splitting, or other types of failure. Load measurements found decreases in the level of stress in the pipe walls after 22 years of continuous deflection [3]. In other words, the specimens have experienced stress relaxation over that period of time. Finally, when these specimens were subjected to additional deflection, their stiffness still exceeded the 46 psi minimum requirement specified in the ASTM product standard for SDR 35 sewer pipe [2].

We feel it is important that consulting engineers and utility managers understand that a PVC sewer pipe with a deflection of 7.5% is far from a structurally critical condition that would require its replacement. PVC pipe will still perform well and continue to support the soil loads for the long-term.

But you may have concerns about the impact that deflection has on the hydraulic capacity of the conduit. The flow capacity will be affected by deflection, since the cross-sectional area of the pipe will be reduced with increasing levels of ovality. Therefore, the degree to which deflection reduces the flow capacity should be considered.

A pipe deflected at 7.5% will have its flow capacity reduced by 0.90%, while a pipe deflected at 10% will have its flow capacity reduced by 1.43%. Even at 20% deflection, the flow capacity is reduced only by 5.47% [4-5]. When considering that sanitary sewer systems are usually sized with generous safety factors, it becomes evident that a deflection of 7.5% is not critical to the flow performance of a sewer system.

Properly installed PVC sewer pipes will not exhibit large deflections. When improperly installed, a flexible conduit reports that fact with larger deflections. Flexible pipes, such as PVC, are the only products that have a post installation test that can validate the contractor's quality of work. The beauty of it is that even when deflection equals the 7.5% limit recommended in the ASTM product standards, it still leaves you with a product fully capable of servicing your needs and with plenty of strength and performance capacity in reserve.

#### Bibliography:

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3. Moser, A. P., "22-Year Stress Relaxation and Strain Limit Testing of PVC Pipes," Uni-Bell PVC Pipe News, Dallas, TX, Spring, 2000, pp. 1-3.
4. UNI-TR-1, "Deflection: The Pipe/Soil Mechanism," Uni-Bell PVC Pipe Association, Dallas, TX, 1997, p. 32.
5. Walker, Robert, "The Effects of Deflection on Sewer Hydraulics," Uni-Bell PVC Pipe News, Dallas, TX, Summer, 1989, pp. 8-9.