

PIPE STIFFNESS AND DEFLECTION TESTING OF COILABLE HDPE CONDUIT AS RELATED TO BURIAL DEPTH

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Foreword

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The purpose of this technical report is to provide information about industry terms related to pipe stiffness and deflection, particularly of HDPE conduit, and to describe technical differences between HDPE and PVC conduit as related to these terms and properties.

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PIPE STIFFNESS AND DEFLECTION TESTING OF COILABLE HDPE CONDUIT RELATED TO BURIAL DEPTH

1.0 INTRODUCTION

High-density polyethylene (HDPE) conduit is the preferred material to house and protect electrical power and communications cables within. It offers unmatched corrosion and chemical resistance, is flexible and durable, and is available in long reel lengths to reduce joints and installation time. HDPE conduit is available in a variety of sizes, colors, dimensions and lengths.

HDPE's availability in long lengths, combined with its ductility, strength, and durability make it ideally suited for trenchless installation technologies such as horizontal directional drilling (HDD). Buried cables installed within HDPE conduit are protected from damage caused by storms, wildlife, vegetation, vehicles, and vandalism, when compared to aerial cables. Conduit also extends the life and reliability of underground cables by providing added protection against ground movement or unstable soil. These permanent raceways also allow for easier and less costly future cable replacements.

HDPE conduit has been used for decades with great success due also to its low coefficient of friction, resistance to corrosion, excellent chemical resistance, and ability to remain ductile (flexible), even at low temperatures. HDPE conduit can be provided on coils or on steel reels in long lengths, ideal for trenchless or plowing installation technologies. For example, a reel of nominal size 1¼ HDPE conduit can contain as much as 8,500 feet (2,600 m). Larger diameter HDPE conduit (e.g. nominal size 8 or greater) is available in straight lengths, also known as "sticks", up to 50 feet (15 m) long.

Polyvinyl chloride (PVC) is an alternative plastic material used for conduit. It is a more rigid material with lower flexibility, and is not coilable. PVC is normally supplied in straight lengths limited to 10 feet (~3 m) or 20 feet (~6 m), with individual pieces joined using solvent cement.

This Technical Report will provide information about industry terms related to pipe stiffness and deflection, particularly of HDPE conduit, and describe technical differences between HDPE and PVC conduit, as related to these terms and other properties.

2.0 PIPE STIFFNESS FOR HDPE CONDUIT AND RELATED TERMINOLOGY

Although HDPE conduit, also known as polymer raceway, is a flexible material, it must provide sufficient Pipe Stiffness to resist both short-term and long-term deflection when buried underground.

Pipe Stiffness (PS) is defined as the value obtained by dividing the force per unit length of specimen by the resulting deflection (typically 5%), in the same units, and at the prescribed percentage deflection. This is expressed as pounds-force per inch of length per inch of deflection or $\text{LbF}/(\text{in.} \cdot \text{in.})$.

PS may also be expressed as $\text{LbF}/\text{in.}^2$ or psi, although pipe stiffness is not a pressure or a stress value, and should not be confused with those values.

$$PS = \frac{F}{\Delta y} \quad [\text{Eq. 1}]$$

where:

PS = Pipe Stiffness ($\text{LbF}/(\text{in.} \cdot \text{in.})$ or $\text{LbF}/\text{in.}^2$ or psi)

F = Force (pounds per lineal inch)

Δy = vertical deflection (inches)

Requirements for evaluating Pipe Stiffness of HDPE conduit and related test methods are clearly described in industry product standards such as ASTM F2160¹, NEMA TC 7², CSA C22.2 No. 327³, and UL 651A⁴.

When HDPE conduit is considered for underground installations, there have been cases where Pipe Stiffness (PS) and the term “Crush Strength” are used to determine strength relative to other materials, regardless of their property differences. In reality, “Crush Strength” is a term that is often misapplied to thermoplastic pipes (e.g. HDPE and PVC). Crush Strength implies a brittle failure when compressed, such as buckling or cracking of the pipe wall, whereas flexible piping materials such as HDPE can actually deflect in excess of 25% with no signs of wall buckling, cracking or splitting.

Terms such as “Pipe Stiffness”, “Deflection Load” or “Minimum Deflection Load” are the correct and more appropriate engineering terms to describe how much deflection a flexible conduit can withstand without damage.

¹ ASTM F2160 *Standard Specification for Solid-wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)*, ASTM International, USA.

² NEMA TC 7 *Smooth-Wall Coilable Electrical Polyethylene Conduit*, National Electrical Manufacturers Association, USA. (NEMA proposing designation change to BI 50064)

³ CSA C22.2 No. 327 *HDPE conduit, conductors-in-conduit, and fittings*, CSA Group, Canada.

⁴ UL 651A *Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit*, ULSE Inc., USA.