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Poisson's Ratio

Named for the French mathematician, Simeon Denis Poisson (1781-1840); Poisson's Ratio is a calculated materials property value. "It is the ratio of lateral unit strain to longitudinal unit strain, under conditions of uniform and unlimited longitudinal stress within the proportional limits. It serves as a measure of lateral stiffness".

Text book values for most homogeneous materials of construction (i.e. steel, cast iron, brass. concrete, etc.) are readily available. For piping materials the **major** Poisson's Ratio is the ratio of axial to hoop strain, with the pipe subject to hoop loading. The **minor** Poisson's Ratio is the ratio of hoop to axial strain, with the pipe subject to axial loading.

The fixed value (calculated) of Poisson's Ratio is used for above ground pipe for determining the vacuum of rating of pipe, based on critical wall buckling as the controlling criteria (i.e. Roark's formula for external pressure of thin wall pipe - long length tubes). Poisson's Ratio is also one of the factors used to analyze stiffness for buried flexible (ring compression design) pipe.

For FRP composite pipe and duct many construction and service variables will lead to a "range" of Poisson Ratio values. These variables include: Pipe diameter, resin used in the corrosion and abrasion liner, resin used in the structural wall, type and thickness of the corrosion and abrasion liner, type and percent of reinforcements used in the inner liner, type of reinforcements of the structural laminate, the % reinforcement to resin matrix of the structural laminate, the "bond" effectiveness between the structural overwrap laminate and the inner liner, for filament wound pipe and duct the helix wind angle (measured from the axis), service temperatures, etc.

Even in full scale testing of FRP composite pipe - variability is likely in test results between identically constructed pipe spools, and thus the calculated Poisson's ratio. In composite pipe measured strains in axial direction are more likely to vary because of the inherent variability from sample-to-sample in composite construction. Also, under sustained axial strain axial stresses will tend to relax with time, yielding varying test results.

Our current recommendation for above ground installations of FRP composite pipe and duct is the use of a major Poisson's Ratio of 0.65, and a minor Poisson's ratio of 0.35. Our current recommendation for buried installations of FRP composite pipe and duct is the use of a major Poisson's Ratio of 0.60, and a minor Poisson's ratio of 0.30. These are conservative recommendations; based on actual test results from many tests, including testing to ultimate; on seven each 30" diameter FRP composite pipe samples; with varying wind angles, types and thicknesses of inner liners, and resins.

These test results, and the recommended Poisson's Ratio for FRP composite pipe, have been confirmed by empirical field data. For example: The use of the recommended Poisson's ratio for vacuum service has predicted within 0.1 psi the actual field vacuum failure of FRP composite duct.