

PVC PIPE ASSOCIATION TECHNICAL BRIEF

SURGE PRESSURE CAPACITY: WHEN “STRENGTH” BECOMES A LIABILITY

Ductile iron promotes itself as a strong material compared to PVC. However, strength in the laboratory does not always translate to strength in a municipal water system. A design example illustrates the point.

DESIGN EXAMPLE FROM AWWA C900

The AWWA C900 standard for PVC pipe contains a design example in Appendix B. The example is repeated here (minus the cyclic surge portion, which is generally not appropriate for municipal water systems).

Design example conditions:

- Pipe diameter: 8 in.
- Working pressure (WP) = 160 psi
- Occasional surge: instantaneous change in flow velocity = 7.0 fps

PVC pipe: DR18 Pressure Class 235 psi

- Occasional surge pressure (P_{OS}) from a 1 fps instantaneous flow change = 17.4 psi
- Anticipated surge pressure = 17.4 psi/fps x 7 fps = 122 psi

Apply the same parameters to ductile iron pipe.

DI pipe: Pressure Class 350 psi

- Occasional surge pressure from a 1 fps instantaneous flow change = 52.3 psi
- Anticipated surge pressure = 52.3 psi/fps x 7 fps = 366 psi

Analysis:

- Design Check #1: Long-term pressure
 - Working pressure (WP) = 160 psi
 - Allowable long-term pressure = Pressure Class

	Max Long-Term Pressure	Allowable Long-Term Pressure	Long-Term Pressure Summary
PVC Pipe	WP = 160 psi	PC = 235 psi	<i>PVC pipe okay for long-term pressure</i>
DI Pipe	WP = 160 psi	PC = 350 psi	<i>DI pipe okay for long-term pressure</i>

- Design Check #2: Short-term pressure
 - *PVC pipe*: Total Short-Term Pressure = WP + P_{OS} = 160 psi + 122 psi = 282 psi
 - *DI pipe*: Total Short-Term Pressure = WP + P_{OS} = 160 psi + 366 psi = 526 psi

	Max Short-Term Pressure	Allowable Short-Term Pressure	Short-Term Pressure Summary
PVC Pipe	Total Pressure = 282 psi	1.6 x PC = 376 psi	<i>PVC pipe okay for short-term pressure</i>
DI Pipe	Total Pressure = 526 psi	PC + 100 psi = 450 psi	<i>DI pipe NOT okay for short-term pressure</i>

Key Points:

- Ductile iron’s high modulus of elasticity causes large surge pressures to be developed.
- Take-aways for a utility:
 - The DI pipe would be overstressed by about 16%.
 - The PVC pipe would not be overstressed, but would still have 33% additional capacity.
 - The DI system would be subjected to a pressure spike of 526 psi (perhaps enough to cause damage to water-system components).
 - The PVC pipe system for the same conditions would experience only 282 psi (about 45% lower than for the DI system).

References: AWWA Standard C900-07; DIPRA “Design of Ductile Iron Pipe”; Uni-Bell Material Comparison “PVC vs Ductile Iron (DI) Pipe – Occasional Surge Pressure: PVC Outperforms DI Pipe”